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FOOD CONSUMPTION AND NUTRITIONAL EFFECTS OF TARGETED FOOD INTERVENTIONS IN BANGLADESH

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Summary

It is a high priority of the Bangladesh Food Policy Project of the International Food Policy Research Institute (IFPRI) to study the effects of public food interventions on household food consumption and nutrition. Accordingly, this report attempts to assess the food consumption and nutritional effects of the Rural Rationing (RR) and the Vulnerable Group Development (VGD) programs, the two large targeted food interventions in Bangladesh to provide food security to the rural poor.

The RR program was designed to distribute rationed rice at concessionary price to low-income families. However, the program was abolished in May of 1992 due to its unsatisfactory performance in reaching the target group cost-effectively. Before its extinction, the RR program accounted for about 20 percent of all foodgrains distributed through the 14 channels of the Public Food Distribution System (PFDS). The VGD program is one of the largest components of the PFDS that distributes a monthly free ration, normally wheat, mainly to destitute women. In 1991/92, the share of the VGD program in total PFDS foodgrain offtake was about 10 percent.

IFPRI conducted a household survey to evaluate the effects of RR and VGD programs. The survey was conducted in eight villages, two in each of the four division of the country. The survey was repeated seasonally to obtain three

observations over one year. This study is based on data from the first survey round conducted in 1991 during the October-November lean season. The first survey round included only the low-income households--RR, VGD, and corresponding two control groups of households. A sample of 553 households (consisting of 200 RR, 117 VGD, and 236 control households) was chosen. Detailed information was collected on income, expenditures, individual food intakes, sanitation, health, morbidity, and anthropometric measurements. Intra-household distribution of food was determined by weighing food intakes of individual household members. Recall method was used for recording food consumed outside home. Anthropometric measurements were taken for all household members.

The results of the comparative analysis suggest that, with income transfers from the programs, monthly income of VGD beneficiary households were significantly higher than that of the control group members. However, the difference of income between RR and control group was not statistically significant. The effect of the RR program in increasing incomes of the poor was minimal, accounting for only 3.7 percent of per capita household income. In contrast, the VGD program transfers 19.4 percent of additional income to individual beneficiaries. Per capita expenditures were higher than income for all groups, showing a dissaving during the lean season.

For the entire sample, food accounted for about 75 percent of total expenditures, on the average. About 55 percent of the average food budget was spent on rice. Foodgrains (rice and wheat) accounted for 86 percent of total

calorie intakes, implying a very little diversity in diet. Average calorie intakes by VGD members were significantly higher than that of the control group members, but the difference was not significant between RR and control household members.

In terms of calorie adequacy, preschool children were at the greatest risk of undernutrition, followed by pregnant and lactating women, among all household members. The average calorie intakes of preschoolers were far below requirements, for both boys and girls. Although calorie intakes of preschool boys were higher than that of girls, the gender difference was not statistically significant in terms of calorie adequacies. There was no significant difference in calorie adequacies of preschoolers between programs and control groups.

Among all age groups, statistically significant difference between calorie adequacy rates of male and female members are found only in adults. Calorie adequacy of female adult members across all programs and control groups were significantly lower than their male counterparts.

Pregnant and lactating women, wives, and other adult women, as well as the male household heads in the VGD program had significantly higher calorie adequacies than the corresponding control group members.

Severely underweight preschool children as percentages of total children in different groups were not significantly different between programs and control groups. Also, the difference in the rates of severely underweight children between boys and girls was not statistically significant.

The comparative analyses suggest that the RR program had no positive effect on nutrition of the program participants. In contrast, the VGD program substantially improves nutrition of the adult household members. However, the program has no significant impact in improving the nutritional status of children.

This study supplements the comparative analysis by the results of the multivariate analysis. The income elasticity of demand for food suggests that a 10 percent increase in household income results in a 7.8 percent increase in food expenditures. However, the calorie-income elasticity in quite low--a 10 percent increase in income increases calorie intakes by only 2.8 percent. The relatively low calorie-income elasticity indicates that the households spend a large portion of increased income in upgrading the quality of their diet.

Income transfer in wheat from the VGD program results in a higher intake of calories than that of other sources of income. However, this difference is not evident in the RR program, which transferred income in rice. On the contrary, the positive and significant relationship between rice price and calorie intakes indicates that the subsidiy on rice price might have resulted in a reduced calorie intake by the RR households.

At the margin, calories are not distributed equally among household members. Preschool children get only 45 percent of their share of incremental calories in the household. This intra-household food distribution pattern, however, does not reflect a deliberate discrimination against the children. The study suggests that several factors, such as, lack of care and knowledge, economic

hardship, and sickness of children are likely to be responsible for the maldistribution of incremental calories.

Healthy mothers have a positive and strong effect on the health status of their children, probably because mothers' good health enables them to take good care of their children. Several other statistically significant determinants of child nutritional status relate to caring behavior. These findings suggest that the gains from improved household food security, and developed health facilities at the community level can be effectively brought to a child by proper caring practices. Nutrition counseling and training programs, if appropriately designed, might play an important role in convincing the mothers or caretakers to improve their caring practices for children.

The short-run preschooler nutritional status elasticity with respect to income is only 0.03. This suggests that the net direct effect of incremental household income on the nutritional status of children is negligible in the short-run. Two "leakages" are mainly responsible for such a minimal effect of income on child nutritional status. A large leakage occurs between increases in household level calorie acquision form increased income, and child calorie intakes. The other leakage occurs when even this modest increase in child calorie intake is only partially translated into the child's growth, because of the sufferings from illness that lower his or her body's absorption capacity of nutrients.

The study evaluates the cost-effectiveness of targeted interventions in improving food consumption and nutrition. The results indicate that, although

income transfer in cash is more cost-effective than that of in-kind transfers, the later is more cost-effective in enhancing household food consumption. However, this finding is valid if the quantity of ration commodity in-kind is greater than the amount of that commodity the household would have consumed without the ration. The VGD income transfer in wheat meets this condition.

The study examines the nutritional consequences of the recent wheat-to-rice swap in the VGD program. The swap was one-to-one, that is, the VGD beneficiaries received the same quantity of 31.25 kilograms of rice ration instead of wheat. Due to the one-to-one wheat-to-rice swap, the program cost increased substantially because rice price is higher than wheat price in both domestic and international markets. Although one-to-one swap increased the real incomes of the recipient households, the findings suggest that the wheat-to-rice swap actually reduced the household nutrient (calorie and protein) consumption, instead of increasing it.

The VGD program is quite successful in improving household food security, and this success is mainly due to the form of income transfer in wheat, more than anything else. Therefore, this study suggests that wheat should be distributed for targeted food interventions, instead of rice, to alleviate the protein-energy malnutrition at a least cost.

To improve the nutritional status of children, however, food intervention programs alone are not cost-effective, in spite of their potentials of significantly improving household food security. Nevertheless, the provision of a low-cost nutrient-dense weaning food for households with malnourished young children,

and proper nutrition counseling and training may extend the VGD-type program's nutritional benefits to children as well.

2

Introduction

Overwhelming undernutrition continues to persist in Bangladesh. About half of the country's 112 million people cannot afford an adequate diet. Freedom from hunger and malnutrition is a basic human right. Therefore, food security and adequate nutrition are beneficial outcomes in themselves. Enhanced labor and intellectual productivity, and hence economic growth is an additional benefit of food security.

Undernutrition is both a cause and a consequence of underdevelopment. A malnourished population contributes less effectively to economic development than a properly fed, physically strong and active population. It is likely that Bangladesh is paying a very high price for economic growth due to the low productivity of her labor force caused by widespread malnutrition. From an economic point of view, therefore, an effort to ensure food security in Bangladesh is a good investment in human capital that will effectively contribute to a healthy growth of the economy.

National food security is defined here as continuous access by all people in a country to a timely and reliable supply of food adequate to maintain an active and healthy life. Thus, one essential element of food security is the availability of adequate food, although there is no necessary connection between food security and food self-sufficiency. The other essential element in food security is the access to adequate food, which implies effective demand or sufficient purchasing

power of people to acquire enough food. While Bangladesh is at the verge of attaining self-sufficiency in foodgrain production, millions of her population lack access to enough food owing to their inadequate purchasing power, and thus remain seriously underfed.

Economic growth that creates employment for the poor, raises their real incomes, and consequently increases their purchasing power. Economic growth is, therefore, necessary for sustained improvement in food security. However, economic growth is a slow process to improve food security. Even if a rapid growth can be achieved, there is no guarantee that the condition of the poor will improve unless equitable distribution of incremental national income is ensured. Waiting for such an uncertainty may not be affordable for a country like Bangladesh where millions of people are at a risk of undernutrition-related death.

As a transient solution to the problem of food insecurity, a targeted intervention of transferring income can be an efficient way of increasing real income, and thereby, improving household food security of the poor. Distributing rationed food to a target group is a well known way of transferring income. To improve the cost-effectiveness of such a program, income should be transferred to those with the greatest nutritional needs. A well-managed and appropriately targeted intervention improves the nutritional status of the poor in a cost-effective way by excluding the non-needy members of the population.

It is a high priority of the Bangladesh Food Policy Project of the International Food Policy Research Institute (IFPRI) to assess the effects of public

food interventions on household food consumption and nutrition. The analyses in this report incorporate the consumption and nutritional effects of the Rural Rationing (RR) and the Vulnerable Group Development (VGD) programs, the two large targeted food interventions in Bangladesh to provide food security to the poor. The RR program was designed to distribute rationed foodgrain at concessionary prices to low-income families. However, the program was abolished in May 1992 due to its unsatisfactory performance in reaching the target group cost-effectively. The VGD program is one of the largest components of the PFDS that distributes free foodgrain ration mainly to destitute women.

This report is organized in eight sections. Following the summary and the introductory sections, an overview of the Public Food Distribution System (PFDS) is provided, and the two study programs are described in Section 3. Section 4 presents the survey design and data collection procedures. A comparative static analysis of the effects of RR and VGD programs is provided in Section 5. The determinants of food consumption and nutritional status of sample households and their members are highlighted in Section 6 in a multivariate analysis. Section 7 provides the cost-effective analysis of targeted interventions. The report concludes with a synthesis of policy recommendations that have emerged from the analyses.

3

The Public Food Distribution System and the Study Programs

AN OVERVIEW OF PFDS

The Public Food Distribution System (PFDS) originated in 1943 during the Bengal famine. Its initial objective was to guarantee a minimum quantity of foodgrains at controlled prices to urban consumers. Foodgrain distribution under the system has expanded rapidly since the liberation of Bangladesh in 1971. During the later part of the 1970s, it distributed almost twice as much foodgrain as during the later half of the 1960s. In 1991/92, total foodgrain offtake from the system was 2.35 million metric tons. This was equivalent to about 13 percent of all foodgrains available for consumption in the country.[1]

Historically, the relatively well-off section of urban population have been the principal beneficiaries of subsidized foodgrain distributed through the PFDS. The benefits of subsidized food largely bypassed the rural population and the urban poor, whose needs for subsidized food are greatest. The recent directions of the PFDS are, however, encouraging. Improved foodgrain distribution through better targeting to achieve poverty alleviation objectives are receiving increasing attention of the government and the donor agencies. The share of programs

[1]Foodgrain availability is calculated as total domestic production net of seed, feed, and wastage, plus imports, and minus increases in government stocks and stock losses. In 1991/92 total foodgrain availability for consumption has been estimated at 18.35 million metric tons.

directed to the poor[2] in total PFDS offtake was 32 percent in 1978/79, which was increased to 53 percent in 1990/91.

At present, PFDS operates through 13 distribution channels that broadly fall into two groups, 8 monetized and 5 nonmonetized channels. Each channel represents implicitly some target groups. Monetized channels consist of statutory rationing (SR) mainly for government employees in six urban areas (that is, four metropolitan cities--Dhaka, Chittagong, Khulna, and Rajshahi, and two municipal towns--Narayanganj and Rangamati); essential priorities (EP) for the armed forces, Bangladesh Rifles, police, Ansars (paramilitary group), and jail staffs; other priorities (OP) for government employees outside SR areas, jail and hospital inmates, students' hostels, and so forth; large employers (LE) for industrial workers; flour mills (FM) for approved mills that are allotted wheat at a subsidized price; and open market sales (OMS), marketing operation (MO), and free sale (FS) for the general population at subsidized prices. The nonmonetized channels serving the poor include Food for Work (FFW), Vulnerable Group Development (VGD), Test Relief (TR), Gratuitous Relief (GR), and Cluster Village (CV). The monetized channels are managed by the Ministry of Food and the nonmonetized channels by the ministry of Relief and Rehabilitation. Before its abolition, the Rural Rationing program belonged to the monetized channel of the PFDS. Table 1 shows the distribution of foodgrains by channels and their shares in total PFDS offtake in 1990/91, the last full year of RR operation.

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[2] Programs for the poor include modified or rural rationing, food for work, vulnerable group development, and relief channels.

Table 1—Distribution of foodgrains by channels and their relative shares in the Public Food Distribution System, 1990/91

Channels	Total offtake			Share in PFDS		
	Rice	Wheat	Total	Rice	Wheat	Total
	(thousand metric tons)			(percent)		
Rural rationing	478	0	478	19.5	0.0	19.5
Flour mills	0	345	345	0.0	14.1	14.1
Statutory rationing	55	205	260	2.2	8.4	10.6
Other priorities	90	144	234	3.7	5.9	9.6
Essential priorities	84	55	139	3.4	2.2	5.7
Open market sales	80	13	93	3.3	0.5	3.8
Large employers	7	34	41	0.3	1.4	1.7
Free sales	6	0	6	0.2	0.0	0.2
Marketing operation	0	0	0	0.0	0.0	0.0
Total monetized	800	796	1,596	32.7	32.5	65.2
Food for work	58	429	487	2.4	17.5	19.9
Vulnerable group development	116	133	249	4.7	5.4	10.2
Test relief	51	23	74	2.1	0.9	3.0
Gratuitous relief	19	13	32	0.8	0.5	1.3
Cluster village	5	6	11	0.2	0.2	0.4
Total nonmonetized	249	604	853	10.2	24.7	34.8
Total	1,049	1,400	2,449	42.8	57.2	100.0

Source: World Food Programme, "Bangladesh Foodgrain Forecast (April)", Dhaka, 1992 (Mimeo).

This study attempts to assess the food consumption and nutritional effects of RR and VGD programs. A description of each program follows. Table 2 provides a comparative summary of the two programs.

THE RURAL RATIONING PROGRAM

In April 1989, the Rural Rationing program was introduced in the PFDS as a monetized channel replacing the Modified Rationing (MR) program. Started in 1956, the MR program was designed to distribute subsidized foodgrains to the rural poor. MR allocations were determined according to government grain stocks. Usually, surplus foodgrain stocks from the Statutory Rationing (SR) program were diverted to the MR program. Because of the well-documented failure of the MR program to benefit the rural poor, the program was discontinued in 1989.

The RR program was designed to provide foodgrains (mainly rice) at a subsidized price to low-income people in rural and municipal areas. Foodgrains distributed under the RR program were priced at 25 percent less than the SR price. Excluding the six SR areas, the RR program operated all over the country. Unlike the MR program, the RR program had a specific allotment of foodgrain for distribution among eight percent of the population of non-SR areas according to the 1981 population census. This translates into six percent of the non-SR population reported in the 1991 census. The targeting criteria for selecting beneficiaries of the RR program were as follows:

Table 2—Features of Rural Rationing (RR) and Vulnerable Group Development (VGD) programs

Program Features	RR (1990/91)	VGD (1991/92)
Sources of program resources (rice for RR, wheat for VGD)	Bangladesh Govt. (100%)	WFP(46%), Canada (25%), EEC(7%),Australia(5%), FRG(3%),Belgium(1%), GOB(11%)
Commodities distributed	Rice	Wheat
Program size a) Commodity ('000 tons) b) Value ($ million) c) Entitlement/household d) Price to beneficiary	 478 (rice) 130.0 4.5 kg/month 25% less than SR price	 202 (wheat) 39.4 31.25 kg/month Free (for training)
Target group	Rural poor	Destitute women
Regions	All rural areas (non-SR areas)	Focused on distressed regions
Seasons	Year-round	Year-round
Development activities	None	Integrated poultry program; pilot credi scheme; self-employment through cottage industries; functional literacy; health, nutrition, and agricultural extension training
Leakage	70%	14%
Cost per 1 taka income transfer	Tk 6.55	Tk 1.50

Source: IFPRI and the World Food Programme, various reports and personal communications.

1) A landless or near-landless household whose total foodgrain production did not meet the household's consumption requirements for more than two months in a year;

2) A household that was not required to pay a *Chowkidari tax*[3] of more than 3.00 taka[4] per year; and

3) A household that was not covered under the VGD program.

The beneficiaries of the RR program were selected by administrative review, using a committee of local government officials and an elected chairman of the union council. The Union Council chairman issued ration cards to beneficiaries for identification. Each selected household received a maximum of three ration cards for three adult household members. The entitlement of each ration card was 1.5 kilograms of foodgrain per week.

The RR foodgrain was distributed to beneficiaries by private dealers who were responsible for maintaining ration outlets and transporting foodgrains from the government godowns (warehouses). Originally, the local Member of Parliament (MP) was responsible for selection and appointment of RR dealers in his or her area. After the fall of the former president Ershad's government in December 1990, the system of dealer selection by the MPs was abolished by an executive order, and dealer appointments were made by a committee of government officials. A total of 10,126 dealers were appointed in the RR program.

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[3] The Chowkidari tax is imposed on rural households by the Union Council to supplement its resources. The tax is based on the value of a household's owned land and other assets.

[4] The official exchange rate for the taka, the currency of Bangladesh, on June 1, 1993, was taka 39.70 per US$1.00.

Ration shops were usually located in the *hat* or village market place. The location of a ration outlet in a village *hat* minimized the opportunity cost of time spent by beneficiaries in obtaining rations. The dealer was required to keep his shop open twice a week on *hat* days.

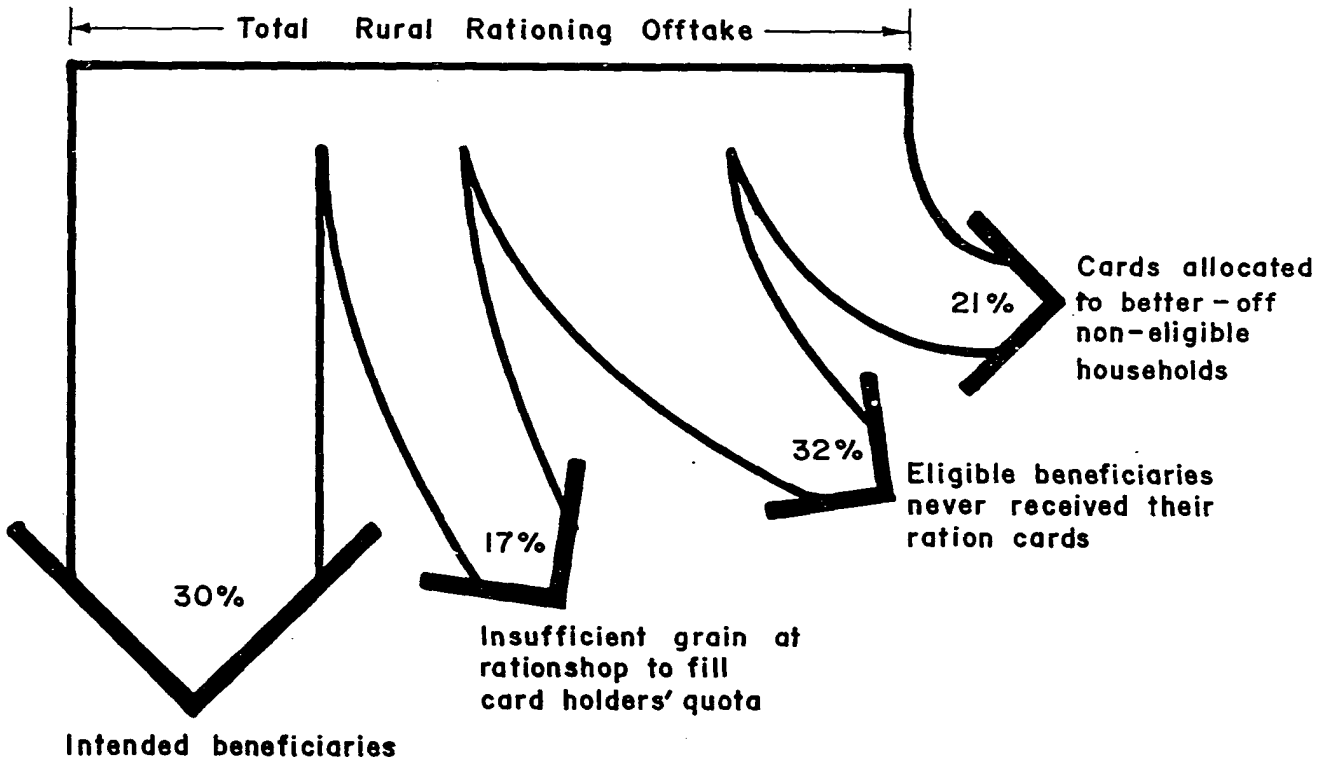
The officials of the government food directorate supervised the RR program. The key persons for supervision were food inspectors and *thana* food controllers. The district controller of food was responsible for overall management of the RR program in his district.

In early 1991, IFPRI conducted a survey on the operational performance of the RR program. The survey covered all the 20 regions (formerly districts) of the country. Based on the data drawn from the survey, the IFPRI study critically evaluates the effectiveness of the RR program (Ahmed 1992). The study estimates the leakage of resources intended for the target group to the nontarget population. The estimates suggest that the total leakage of rice from the RR program was about 70 percent. The total leakage comprises of three components: nonfulfillment of eligibility requirements, (21 percent); eligible beneficiaries never received their ration cards (32 percent); and beneficiaries received less than their full entitlements (17 percent). Figure 1 illustrates these components of leakage.

The IFPRI study notes that the high fiscal cost of the ration subsidy (taka 2.15 billion or US$60 million in 1990/1991) and the leakage of resources to those who were not poor far outweighed any benefits of the program. Adjusted for leakage, the total benefit from the program (in income transfer) was taka 328

Figure 1—Leakages in rural rationing distribution

(percentage of total RR offtake)



Source : IFPRI Rural Rationing System Performance Survey, 1991.

million (US$9 million) in 1990/91. The government spent taka 6.55 to transfer taka 1.00 of income to a consumer eligible for the program. The study concludes that a combination of factors, such as a lack of supervision of the program by government food officials, appointment of many inexperienced ration dealers, inadequate commission paid to dealers, and the existence of ample scope and incentives for rent seeking affected the RR program so that its performance was far from satisfactory.

The findings of the IFPRI study contributed to a government decision to abolish the RR program in May 1992. Before its demise, the RR program was the largest among all PFDS channels, accounting for about 20 percent of total PFDS foodgrain offtake in 1990/91 (Table 1).

THE VULNERABLE GROUP DEVELOPMENT PROGRAM[5]

The Vulnerable Group Development (VGD) program is one of the non-monetized channels of the PFDS. In 1991/92, the share of the program in total PFDS foodgrain offtake was 9.8 percent. The program was originated in 1975 as a relief program for families affected by natural calamities. Currently, the objective of the VGD program is to provide food assistance as a development input with the aim of enabling destitute women to improve their economic and social condition (WFP 1992).

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[5] The VGD program has three sub-projects, the Union VGD Centers, Women's Training Centers, and Institutional Feeding and Development Centers. This report describes the union VGD center sub-project, which accounts for about 90 percent of total program resources.

Although the VGD program operates nation-wide, it concentrates more resources in distressed areas of the country. Two-thirds of the resources are directed to one third of the *thanas*. Consequently, coverage is double in the distressed areas. The World Food Programme has devised a map where each *thana* of the country has been categorized by its relative distress level (Figure 2 in Section 4). The distress level is determined by factors such as foodgrain surplus or deficit, agricultural wage rate, population density, landless households, employment opportunities, and susceptibility to natural disasters.

Like RR program, the VGD program beneficiaries are selected by administrative review, using a committee of local officials. The VGD selection committee selects the beneficiaries according to criteria such as: female headed household (widowed, separated from husband, divorced, disabled husband), landlessness, low and irregular income, no earning member in the household, and lack of productive assets. The women receive a monthly free ration, normally 31.25 kilograms of wheat[6] which is distributed at the union center on a fixed day. Some centers impart training, mainly on various income generating activities. Each beneficiary is enrolled on the program for two years. About 50,000 women and their families are currently enrolled in the VGD program.

The probability of gaining access to the VGD program by a rural household is estimated in this study from survey data (Appendix 2). If a rural landless household meets the other selection criteria besides landlessness, then

[6] In 1992/93 the program distributed rice instead of wheat.

that household has 91 percent probability in obtaining access to the program. This indicates that the program is well-targeted.

The present study estimates leakage of resources from the VGD program at about 14 percent. The program lowers leakage by empowering its recipients. Because the VGD cardholders meet once a month to collect their ration (and then some of them attend a common training session), they establish a group identity. The program is also better publicized and supervised than the RR program. The IFPRI household survey reveals that 100 percent of VGD beneficiaries are aware of their entitlement. Because of low leakage and relatively low administrative costs, the VGD program transfers taka 1 of income to an eligible beneficiary at a cost of taka 1.50.

4

Survey Design and Data Collection

To assess the consumption and nutritional effects of RR and VGD programs, IFPRI conducted a household survey. The survey was repeated seasonally to obtain three observations over one year.

The present study is based on the first survey round data.[7] The first survey round was conducted in 1991 during the October-November lean season (before the harvest of *Aman*, the largest rice crop). The RR program was in operation during the first survey round. The survey was conducted only in fully and well-operating RR locations to capture the potential nutritional impact of the program. The first survey round included only the low-income households, that is, RR, VGD, and two comparable control groups of households.

The survey was conducted in eight villages, two in each of the four divisions of the country. Four of the survey villages are located in distressed areas and the other four in non-distressed areas. The four distressed areas have been identified using the World Food Programme's distress map where *thanas* are identified by distress factors. Two distressed villages and two non-distressed villages are located in infrastructurally developed areas. The other four villages are from relatively poor infrastructure locations. The locations of the survey villages are spotted on the World Food Programme's distress map of Bangladesh as shown in Figure 2.

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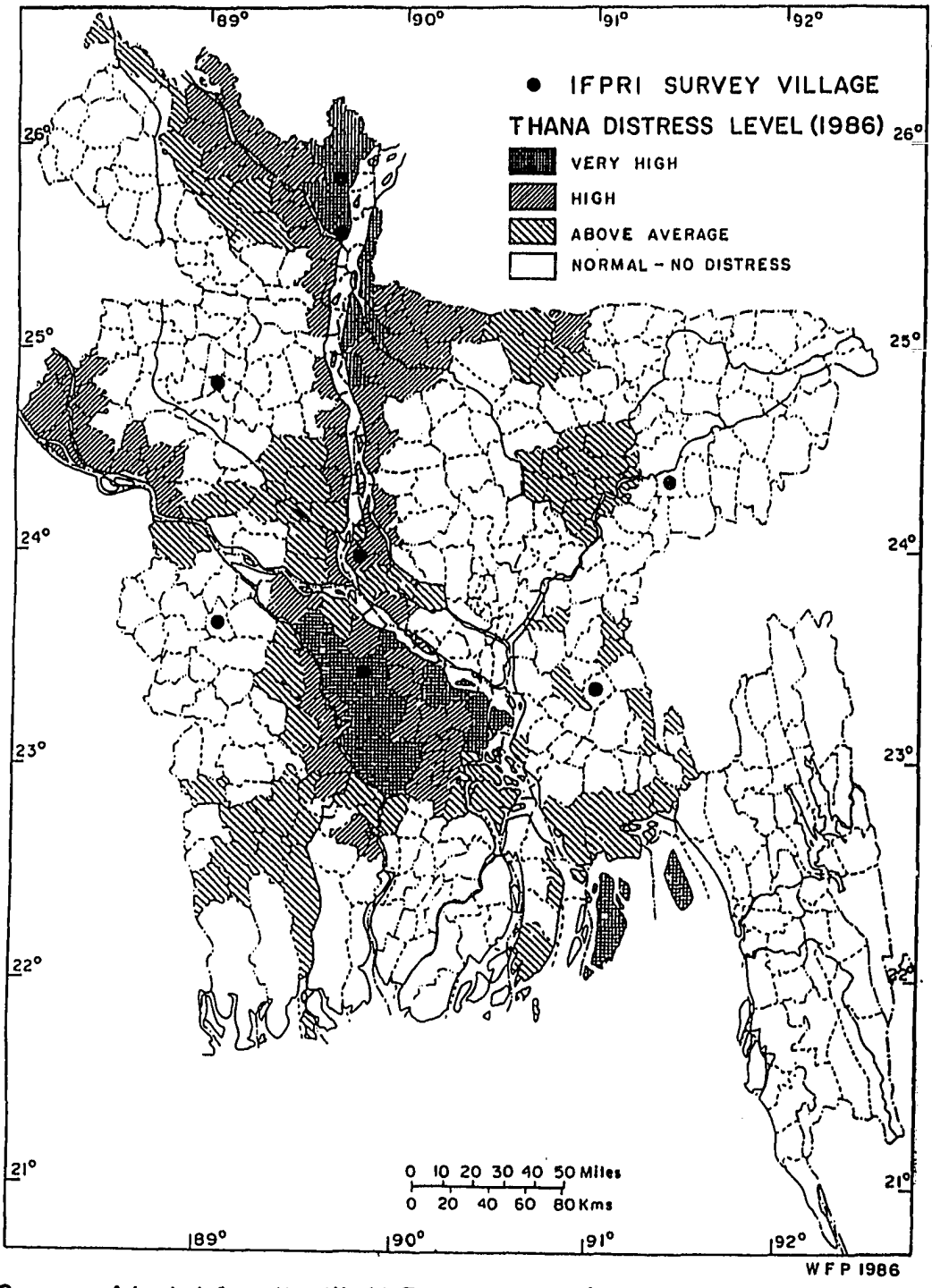
[7] A forthcoming IFPRI report will incorporate analyses of all of the three survey round data.

Figure 2—Locations of the survey villages



Source : Adapted from the World Food Programme's distress map of Bangladesh.

The first part of the household survey consisted of a census (100 percent of the households) of the eight selected villages. A total of 3,194 households were surveyed in the census. A sample of 553 households (consisting of 200 RR, 117 VGD, and 236 control households) was chosen in the first round. Appendix 3 describes the sampling procedure. All VGD sample households were selected from the distressed villages, while the RR sample was drawn from all eight villages. Of the 236 control households, 142 household were located in four distressed villages, therefore, these households were selected as control group for the VGD sample. The sample size was enlarged from 553 households in the first round to 737 households in the second and third survey rounds to include households from the higher income groups.

Two questionnaires were designed to obtain information from the respondents. One questionnaire was designed to collect socio-economic information including household income and expenditures, and the other to record data on sanitation, health, individual food intakes, and anthropometric measurements.

Three survey teams were formed, each consisting of three female and three male investigators, and a supervisor. A team of two investigators, one male and one female, collected information from each sample household. A survey coordinator harmonized the activities of the survey teams.

5

A Comparative Analysis of Program Effects

This section presents descriptive results from the household survey. The effects of the two targeted food interventions--RR and VGD--on the beneficiaries are compared with the respective control groups of households. Major findings of these static comparisons are highlighted as follows.

HOUSEHOLD CHARACTERISTICS

- Table 3 presents the characteristics of RR, VGD, and control households. Family sizes are relatively larger than the average family size of low-income rural households [about 4 persons, according to the 1988/89 Household Expenditure Survey (HES)(BBS 1991)] because households with preschool children were purposively included in the sample.
- Average years of schooling of parents are very low in general and extremely low for the mothers. Among adult household members, 69 percent of the male and 90 percent of the female never attended school.
- As expected, the VGD sample has a high proportion of female-headed households (about 28 percent) as compared to the other groups. According to the 1988/89 HES, 4.4 percent of the rural households in Bangladesh are female-headed.

Table 3—Characteristics of respondent households

Characteristics	RR	Control	VGD	Control	All
Number of sample households[a]	200	236	117	142	553
Household size (persons)	6.2	5.1	5.6	5.2	5.6
Male	3.0	2.6	2.5	2.6	2.7
Male children under 5 years	0.8	0.8	0.6	0.7	0.7
Female	3.2	2.5	3.1	2.5	2.9
Female children under 5 years	0.7	0.7	0.5	0.7	0.7
Years of schooling, father	1.6	1.0	1.6	1.2	1.3
Years of schooling, mother	0.5	0.4	0.6	0.4	0.5
No schooling, adult male (%)	62.6	77.0	65.3	75.5	68.9
No schooling, adult female (%)	88.1	91.8	88.6	92.3	89.7
Female-headed household (%)	6.0	3.8	27.5	3.8	9.8
Own cultivable land (acre)	0.21	0.10	0.17	0.11	0.15
Per capita monthly income (taka)[b]	190	189	213	186	195
Per capita monthly expenditure (taka)[c]	201	263	240	233	254
Per capita monthly income transfer (taka)	7	0	41	0	-
		(percent)			
Principal occupation of household head Farmer	12.0	6.4	6.0	7.0	8.3
Wage earner	53.0	67.4	44.4	66.9	57.3
Craftsman	2.5	0.8	4.3	0.7	2.2
Small business	16.5	11.4	9.4	12.0	12.8
Salaried professional	3.0	0.8	4.3	0.0	2.4
Fisherman	3.5	2.1	5.1	2.1	3.3
Other	9.5	11.0	26.5	11.3	13.8

Source: International Food Policy Research Institute, "Consumption and Nutrition Survey, 1991/1992,"Bangladesh.

[a]The control group has a total of 236 households, all of which are control households for the RR program. The control group for the VGD program (142 households) is a subset of the total control group. Thus, the total sample of 553 households is comprised of 200 RR, 117 VGD, and 236 control households.

[b]Income includes income transfer from programs.

[c]Expenditure includes income transfer from programs.

■ Since the majority of the sample households are landless, wage earning is by far the major occupation of the heads of households. For the entire sample, about 63 percent of households do not own any land except homestead land.

■ Table 4 identifies the sources of household water use. Virtually all households have access to safe drinking water. However, more than one-third

INCOME

■ Table 3 shows that the average monthly per capita income is taka 195 for the entire sample which is substantially lower than the rural average per capita monthly income of taka 484 reported in the 1988/89 HES. Per capita monthly expenditures are higher than income for all groups, showing a dissaving during the lean season when the survey was conducted.

■ Per capita incomes of RR versus control, and VGD versus control without income transfer from programs are not statistically significantly different. With income transfer, however, VGD income is significantly higher than that of the control group members. The difference of income between RR and control groups is not statistically significant with income transfer from RR program.

■ The effect of the RR program in increasing incomes of the poor is minimal, accounting for only 3.7 percent of per capita household income. In contrast, the VGD program transfers 19.4 percent of additional income to individual beneficiaries.

Table 4—Sources of household-water use, all households

Source of water	Drinking	Cooking	Utensils	Washing/ Bathing	Washing Clothes
			(percent)		
Tubewell	97.5	66.7	57.0	13.6	11.8
Well	2.2	4.3	4.9	1.4	1.4
Pond	-	21.7	30.2	67.3	68.4
River/canal	-	5.8	6.5	14.1	14.1
Multi source	0.4	1.5	1.5	3.7	4.3

Source: International Food Policy Research Institute, "Consumption and Nutrition Survey, 1991/92," Bangladesh.

Note: Numbers may not add to 100 because of rounding.

EXPENDITURE

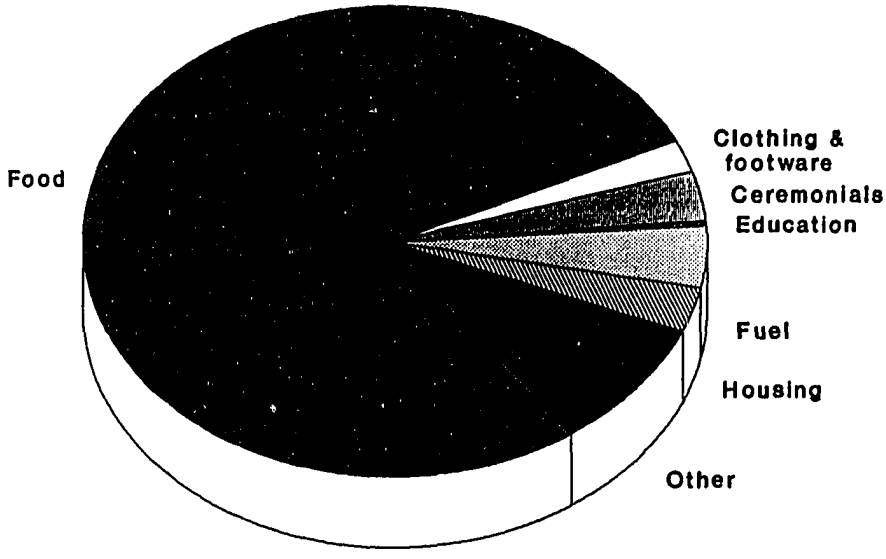
- Household consumption expenditures are used in the analysis as a proxy for income. Based on the permanent income hypothesis, Friedman (1957) argues that expenditures are likely to reflect permanent income and hence a better determinant of consumption behavior.

- Figure 3 shows the shares of household expenditures spent on major consumption items. On the average, 75 percent of total household expenditures are spent on food. VGD households spend relatively more on food and ceremonials (Appendix 1, Table 1.1).

- For the entire sample, about 67 percent of total food expenditures are accounted for by purchased food (Appendix 1, Table 1.2). The composition of source of food expenditures is different for VGD households due to the high share of imputed value of ration food.

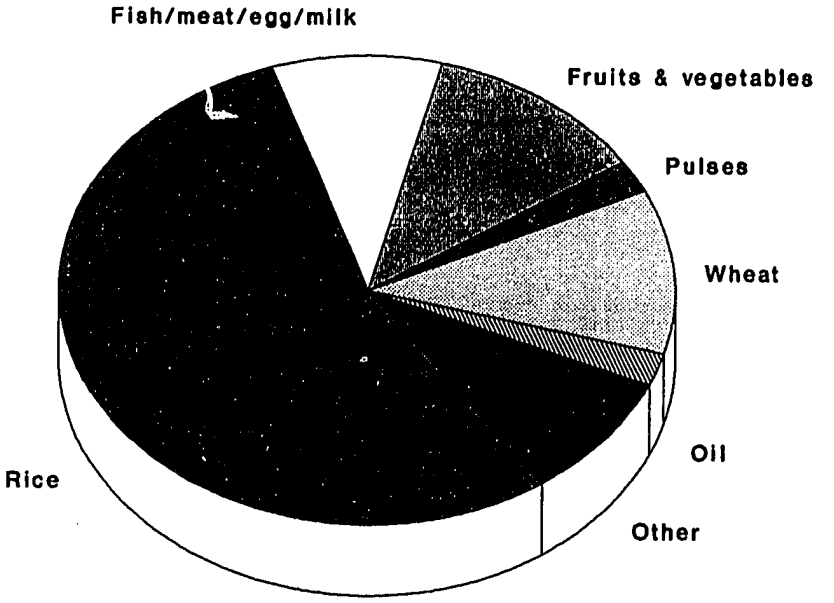
- Figure 4 presents the breakdown of the household food budget allocated to each food group for the entire sample. A comparison of the patterns of food expenditures across programs indicates major variations in rice and wheat expenditures (Appendix 1, Table 1.3). Since VGD households receive wheat ration, and RR, rice ration, their imputed expenditures on wheat and rice are higher than the control households. The breakdown of the quantities of acquisition of different food items is shown in Appendix 1, Table 1.4.

Figure 3-Share of household expenditures on major items
(all households)



Source: IFPRI Household Survey, 1991/92.

Figure 4-Household food budget allocation
(all households)



Source: IFPRI Household Survey, 1991/92.

CALORIE INTAKE AND COMPOSITION

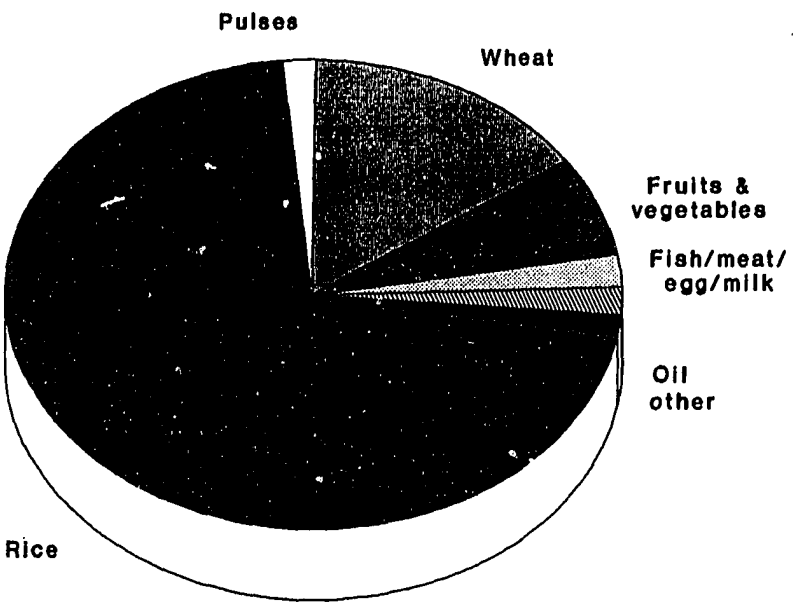
- Figure 5 illustrates the pattern of household-level calorie intakes. Estimates of average daily calorie intakes are based on the 24-hour household food weighing, and recall (for food consumed outside home) methods. Calorie intakes per capita, as well as per adult equivalent unit (AEU) are presented in Appendix 1, Table 1.5. Calorie intakes per adult equivalent unit is a more appropriate indicator of energy consumption than calorie per capita calculation, because AEU incorporates the specific calorie requirements for each age and sex of individual family members. Adult equivalent unit represents the calorie requirements of an adult male. Appendix 4 provides the method of calculating the adult equivalent energy intakes.

- Average calorie intakes by VGD members are higher than that of the control group members, and this difference is statistically significant. The difference in average calorie intakes between RR and control household members is not significant.

- For the entire sample, foodgrains (rice and wheat) account for about 86 percent of total calorie intakes, implying a very little diversity in diet. Figures 4 and 5 illustrate the overwhelming dominance of rice in the diet. Rice accounts for about three-fourths of total calorie intakes by RR households. Consumption of wheat is higher for VGD households than that of the other groups, due to their large entitlement of wheat ration.

- The costs of calorie acquisition from different food sources are calculated (Appendix 1, Table 1.6). Wheat is the cheapest source of calorie, followed by rice. The most expensive source of calorie is meat, costing about 23 times more than the same calories acquired from wheat.

Figure 5-Calorie composition by food groups
(all households)



Source: IFPRI Household Survey, 1991/92.

INTRA-HOUSEHOLD CALORIE INTAKE AND ADEQUACY

- Intra-household distribution of food was determined by weighing food intakes of individual household members. Recall method was used for recording food consumed outside home. Data were collected for every member of the household over a 24-hour period.

- To determine calorie adequacy of a household member, the calorie intakes are compared with individual calorie requirements. The method of estimating calorie requirements of individual family members is presented in Appendix 4. Table 5 presents estimates of calorie intakes and calorie adequacy ratios (intakes divided by requirements, expressed in percentage terms) classified by age and sex for the programs and control groups. Inestimating preschooler calorie adequacy, only fully weaned children are considered because data on calorie intakes from breast milk were not collected.

- The average calorie intakes of preschool children are far below requirements, for both boys and girls. There is no statistically significant difference in the mean calorie adequacies of preschoolers between programs and control groups.

- Average calorie intakes of preschool boys are consistently higher than that of girls across program groups. This may be an indication of gender biased behavior of households in allocating food, discriminating against girls. Other studies in Bangladesh also document this evidence (Brown, Black and Becker 1982; Chen, Huq and D'Souza 1981). However, as girls' calorie requirements are lower than boys', calorie adequacies are not statistically significantly different between boys and girls.

Table 5—Calorie intakes of groups of individual household members

Gender	Age	RR Daily Calorie Intake	RR Calorie Adequacy	Control Daily Calorie Intake	Control Calorie Adequacy	Levels at which Mean Adequacies are Significantly Different (RR versus conrol)
	(years)	(kcal)	(percent)	(kcal)	(percent)	
Male	<5	825	66.0	768	60.9	n.s.
Male	5+-9+	1,248	81.7	1,269	83.1	n.s.
Male	10+-13+	1,632	84.1	1,501	78.3	n.s.
Male	14+-17+	1,704	74.2	2,014	87.9	n.s.
Male	18+	2,315	86.8	2,367	87.5	n.s.
Male	All	1,712	80.9	1,719	80.6	n.s.
Female	<5	769	65.3	769	65.0	n.s.
Female	5+-9+	1,100	83.4	1,064	81.0	n.s.
Female	10+-13+	1,452	82.5	1,325	75.7	n.s.
Female	14+-17+	1,381	72.9	1,688	87.8	.076
Female	18+	1,635	76.6	1,695	77.7	n.s.
Female	All	1,369	77.1	1,393	76.3	n.s.
All	All	1,535	78.9	1,554	78.4	n.s.
Male hh Head		2,377	88.4	2,380	88.1	n.s.
Female (Spouse)		1,642	74.1	1,735	77.8	n.s.
Preg or Lact		1,678	68.4	1,770	73.0	n.s.
Levels at which Mean Adequacies are Significantly Different (male versus female)						
	<5		n.s.		n.s.	
	5+-9+		n.s.		n.s.	
	10+-13+		n.s.		n.s.	
	14+-17+		n.s.		n.s.	
	18+		0.000		0.000	
	All		0.039		0.018	

(continued)

Table 5—Continued

Gender	Age	RR Daily Calorie Intake	RR Calorie Adequacy	Control Daily Calorie Intake	Control Calorie Adequacy	Levels at which Mean Adequacies are Significantly Different (RR versus conrol)
	(years)	(kcal)	(percent)	(kcal)	(percent)	
Male	<5	843	65.9	752	59.7	n.s.
Male	5+-9+	1,244	81.7	1,259	82.3	n.s.
Male	10+-13+	1,586	81.9	1,524	79.7	n.s.
Male	14+-17+	2,023	86.6	1,882	81.8	n.s.
Male	18+	2,430	93.2	2,334	86.2	0.06
Male	All	1,792	84.6	1,698	79.8	0.07
Female	<5	678	57.2	743	62.4	n.s.
Female	5+-9+	993	75.4	1,063	80.9	n.s.
Female	10+-13+	1,515	85.5	1,329	76.0	n.s.
Female	14+-17+	1,705	89.8	1,640	86.3	n.s.
Female	18+	1,782	85.7	1,590	73.4	.001
Female	All	1,493	81.3	1,332	73.5	.001
All	All	1,624	82.7	1,513	76.7	.001
Male hh Head		2,562	97.0	2,347	86.7	.015
Female (Spouse)		1,935	87.7	1,616	73.1	.000
Preg or Lact		2,200	89.6	1,621	66.8	.000
Levels at which Mean Adequacies are Significantly Different (male versus female)						
	<5		n.s.		n.s.	
	5+-9+		n.s.		n.s.	
	10+-13+		n.s.		n.s.	
	14+-17+		n.s.		n.s.	
	18+		0.059		0.000	
	All		n.s.		0.006	

(continued)

Table 5—Continued

Gender	Age	All	
		Daily Calorie Intake	Calorie Adequacy
	(years)	(kcal)	(percent)
Male	<5	803	63.8
Male	5+-9+	1,256	83.3
Male	10+-13+	1,578	81.7
Male	14+-17+	1,849	80.1
Male	18+	2,357	88.3
Male	All	1,730	81.5
Female	<5	754	63.8
Female	5+-9+	1,065	80.9
Female	10+-13+	1,430	81.2
Female	14+-17+	1,546	81.3
Female	18+	1,693	79.2
Female	All	1,406	77.7
All	All	1,561	79.5
Male hh Head		2,408	89.9
Female (Spouse)		1,731	78.1
Preg or Lact		1,797	73.8
Levels at which Mean Adequacies are Significantly Different (male versus female)			
	<5		n.s.
	5+-9+		n.s.
	10+-13+		n.s.
	14+-17+		n.s.
	18+		0.000
	All		0.001

Source: International Food Policy Research Institute, "Consumption and Nutrition Survey, 1991/92," Bangladesh.

Notes: Levels of significance are based on t-test; n.s. means not significant at the 0.10 level.

Estimates of calorie intakes are based on 24-hour food weighing data.

■ Among all age groups, statistically significant difference between adequacy rates of male and female members are found only in adults. Calorie adequacy of female adult members across all programs and control groups are significantly lower than their male counterparts.

■ Women who were pregnant or lactating at the time of survey had adequacy ratios significantly lower compared to all wives and other adult female members, except the VGD members. Among VGD members, there is no significant difference in calorie adequacy between wives and pregnant or lactating women.

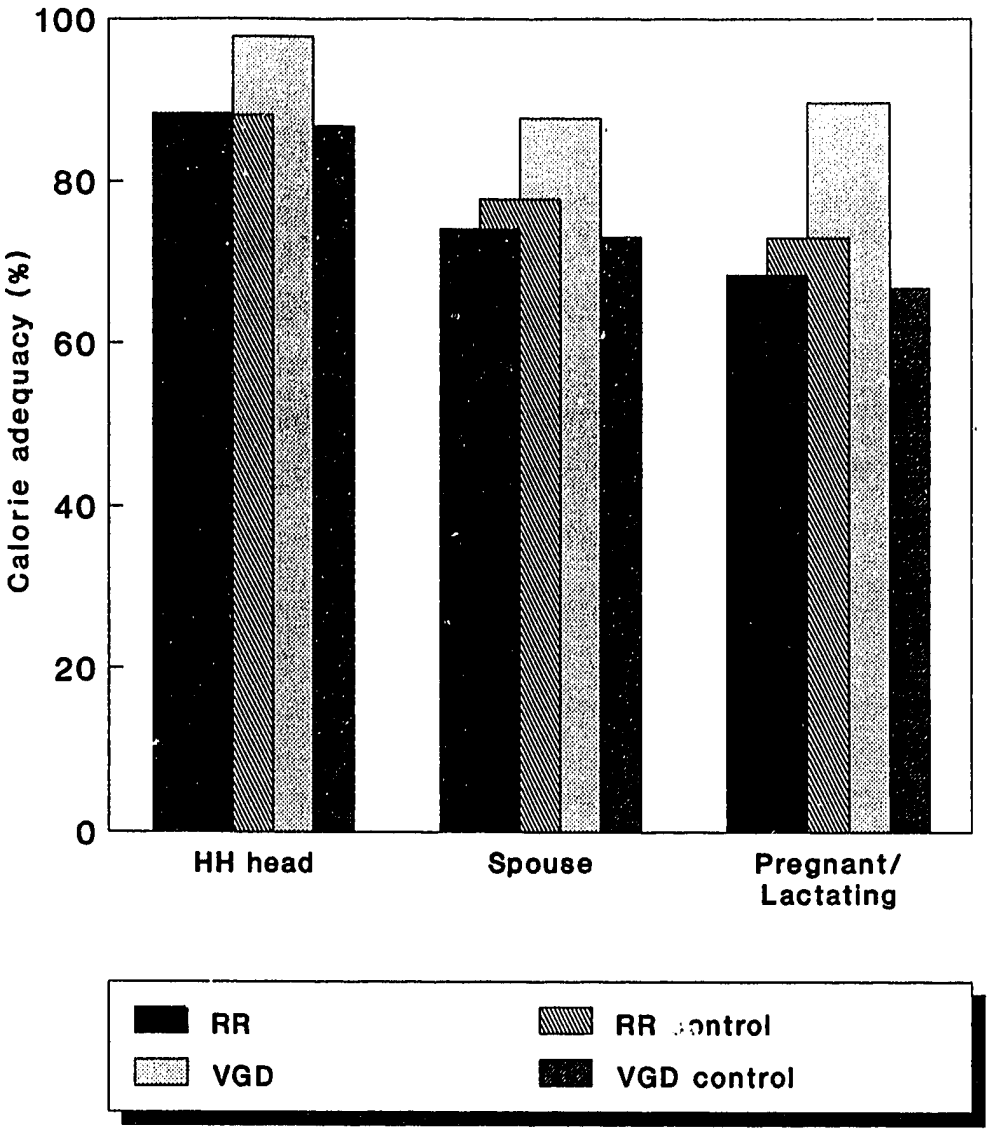
■ Pregnant or lactating women, wives, and other adult women, as well as the male household heads in the VGD households have significantly higher calorie adequacies than the corresponding control group members. Figure 6 illustrates these differences.

■ Figure 7 shows the levels of intrahousehold calorie adequacies by age and sex groups for all sample households. Preschoolers are clearly at the greatest risk of undernutrition, followed by pregnant and lactating women.

NUTRITIONAL STATUS OF PRESCHOOL CHILDREN

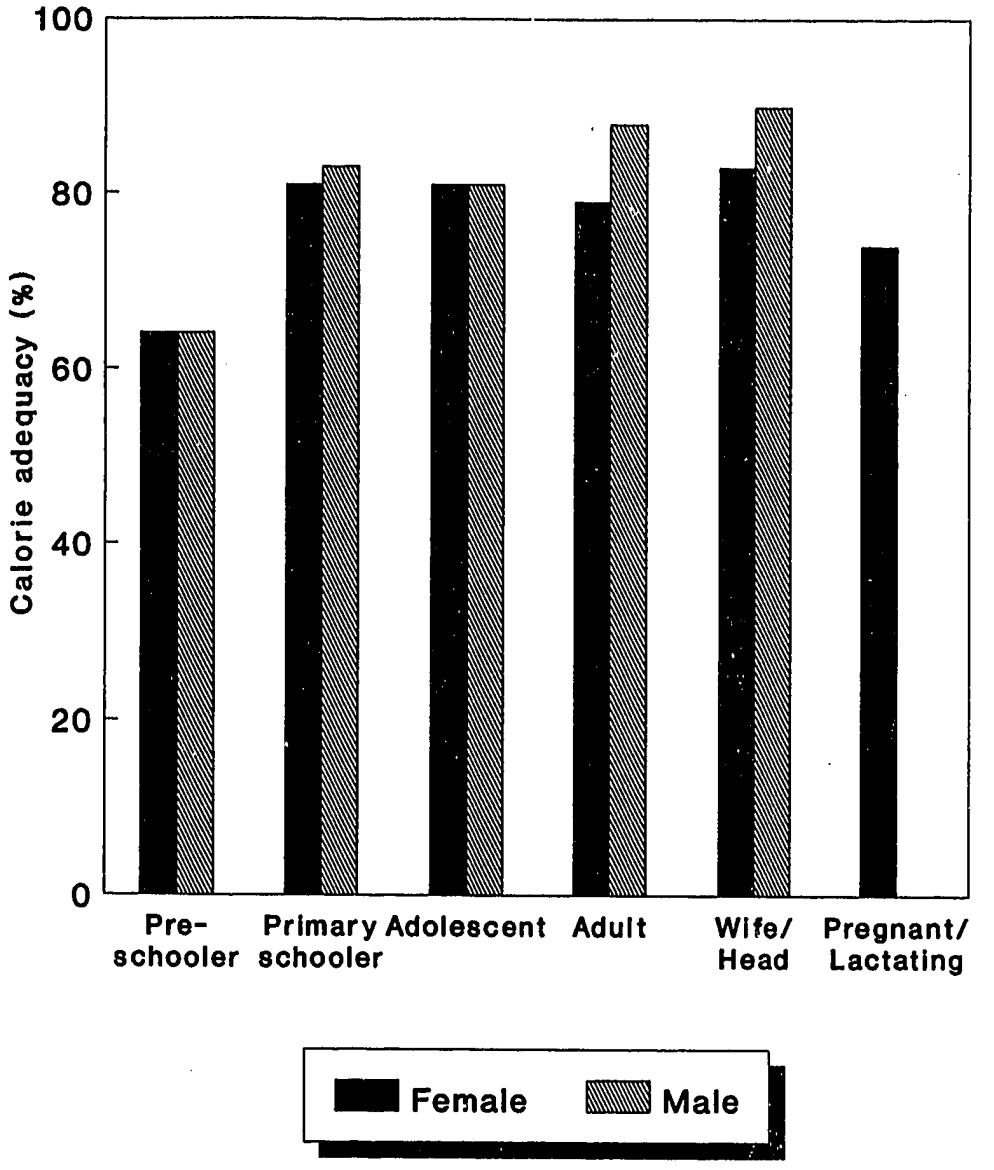
■ The nutritional status of preschool children (aged 6 to 60 months) is determined on the basis of anthropometric data for all preschool children in the sample households relative to a particular growth standard. The standards devised by the U.S. National Center for Health Statistics (NCHS) are used in this

Figure 6-Calorie adeqaucy of adults
(Intake/requirement)



Source: IFPRI Household Survey, 1991/92.

Figure 7-Intrahousehold calorie adequacy
(Intake/requirement)



Source: IFPRI Household Survey, 1991/92.

study. The levels of nutritional status are expressed in Z-score values[6], and percent of standard median.

■ Table 6 reports three indicators of nutritional status of children: height-for-age, a measure of stunting; weight-for-height, a measure of wasting; and weight-for-age, a measure of underweight. Weight-for-height is a short-run measure (indicating acute undernutrition), while height-for-age indicates nutritional status of children over the long-run (indicating chronic undernutrition). Weight-for-age can be viewed as a medium-term indicator, which reflects both acute and chronic undernutrition. The results suggest, for the entire sample, the prevalence of stunting is 50 percent, and wasting, 56 percent. About 71 percent of the preschoolers are under-weight. There is no statistically significant difference in preschooler nutritional status between programs and control groups. Also, the difference in nutritional status between boys and girls is not statistically significant.

■ Table 7 and Figure 8 show the severity of undernutrition among preschool children. Weight-for-age is used as an indicator of undernutrition, which reflects both acute and chronic undernutrition. A threshold level of weight-for-age below -3 Z-score is used to indicate a serious nutritional problem. Severely underweight children as percentages of total children in different groups are not statistically

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[6] Z-score = Actual measurement - 50th percentile standard/standard deviation of 50th percentile standard.

Levels of nutritional status in comparison with a reference population can be conveniently expressed in terms of Z-score values. A Z-score value of zero indicates a child who is "normal"; a negative Z-score value indicates an anthropometric measurement below the one in the reference population. The standards devised by the U.S. National Center for Health Statistics (NCHS) are used in the study.

Table 6—Prevalence of malnutrition among preschool children aged 6 to 60 months

Group	Number of Children	Height-for-Age		Weight-for-Age		Weight-for-Height	
		Average Z-Score	Below 90 Percent of Standard Median	Average Z-Score	Below 80 Percent of Standard Median	Average Z-Score	Below 90 Percent of Standard Median
			(percent)		(percent)		(percent)
RR	281	-2.44	48.0	-2.39	69.8	-1.18	58.0
RR Control	332	-2.59	51.2	-2.46	72.3	-1.20	56.0
VGD	115	-2.48	48.7	-2.40	73.0	-1.15	50.4
VGD Control	189	-2.44	47.1	-2.42	72.5	-1.24	57.1
All	728	-2.52	49.6	-2.43	71.4	-1.19	55.9
Boys	376	-2.49	48.9	-2.40	69.7	-1.22	55.9
Girls	352	-2.55	50.3	-2.45	73.3	-1.15	56.0

Source: International Food Policy Research Institute, "Consumption and Nutrition Survey, 1991/92," Bangladesh.

Note: Differences between programs versus control, and male versus female are not statistically significant at the 0.05 level. Levels of significance are based on Chi-Square test.

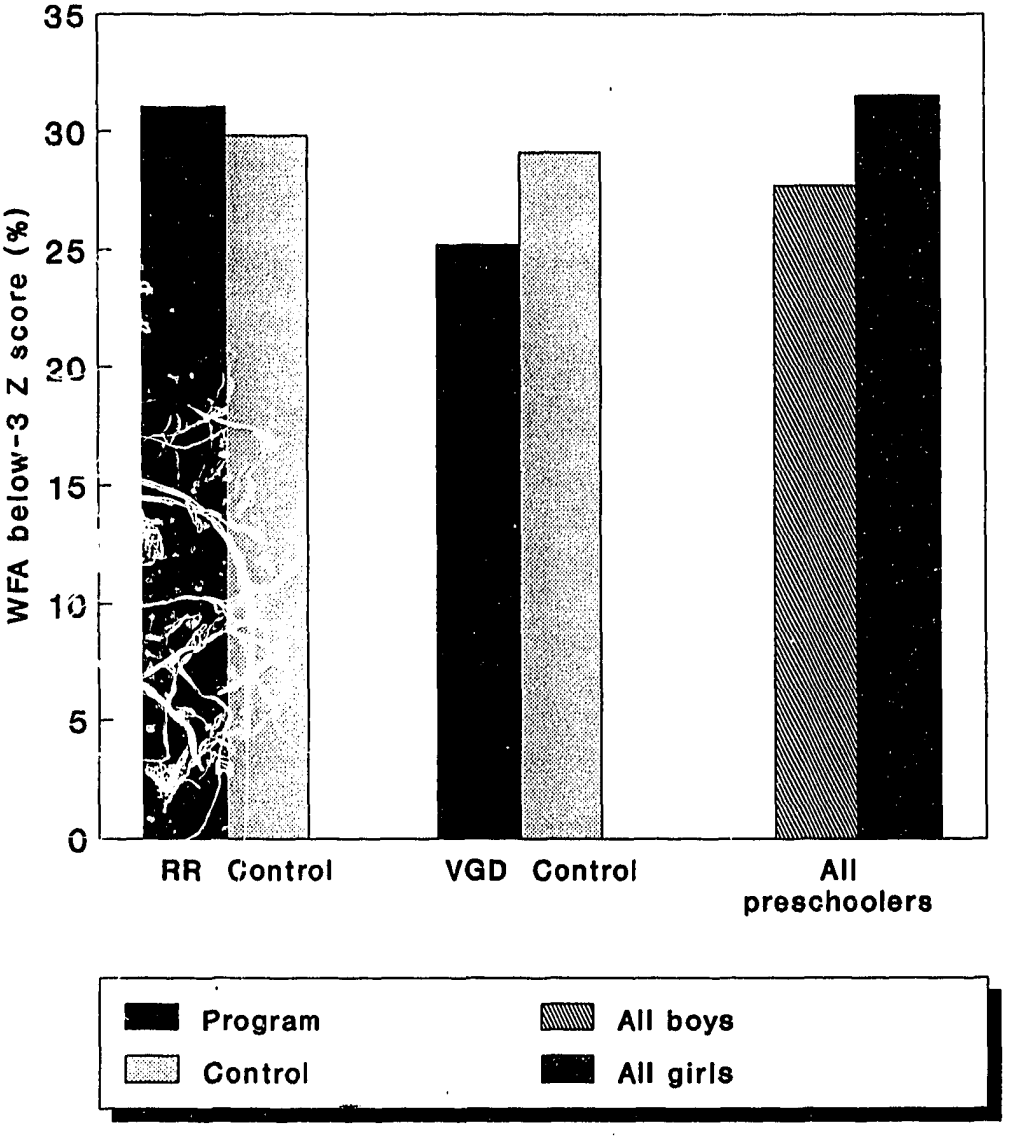
Table 7—Severity of malnutrition among preschool children, aged 6 to 60 months

Group	Number of Children	Mean Z-Scores of Weight-for-Age	Weight-for-Age Below -3 Z-score
			(percent)
RR	281	-2.39	31.0
RR Control	332	-2.46	29.8
VGD	115	-2.40	25.2
VGD Control	189	-2.42	29.1
All	728	-2.43	29.5
Boys	376	-2.40	27.7
Girls	352	-2.45	31.5

Source: International Food Policy Research Institute, "Consumption and Nutrition Survey, 1991/92," Bangladesh.

Note: Differences between program versus control, and male versus female are not statistically significant at the 0.05 level. Levels of significance are based on Chi-Square test.

Figure 8-Severity of malnutrition among preschool children
(Weight-for-age below-3 Z score, %)



Source: IFPRI Household Survey, 1991/92.

significantly different between programs and control groups. A recent study finds higher rates of undernutrition among girls compared to boys in rural Bangladesh (HKI 1993). Although similar findings are apparent in the present study (Figure 8), the difference in the rates of severely underweight children between boys and girls is not statistically significant.

6

Multivariate Analysis of the Effects of Targeted Interventions

The results of the descriptive analyses presented in the preceding section are inadequate because the static comparisons do not permit the separation of program effects from the effects of other factors. In multivariate analysis, the effects of many factors may be isolated from the effects of targeted interventions. In this section the static comparisons are supplemented by the results of multivariate analyses.

INCOME, FOOD EXPENDITURES, CALORIE INTAKES, AND NUTRITIONAL STATUS

Targeted food interventions transfer income to participating households in the programs. The particular interest here is to assess how this extra income influences food consumption and nutrition of the beneficiary household members.

It is important to gain an understanding of the process through which food consumption and nutrition are affected by changes in factors that drive this process. Specifically, this study attempts to determine: how food expenditures increase with higher incomes, to what extent these increased food expenditures generate more calories at the household level, how these additional calories are distributed among the preschool children, and finally, how important are these extra calorie intakes of preschoolers in improving their nutritional status. The focus is on preschool children because they are nutritionally the most vulnerable group among all household members (as identified in the preceding section).

Bouis and Haddad (1990a) suggest a special class of multivariate analysis--the recursive system--to estimate the contribution of factors at each stage in the process outlined above. Following Bouis and Haddad, a four-stage recursive system has been formulated in this study to measure the sequence of causality running from:

(1) Household income → household food expenditures;

(2) Household food expenditures → household calorie intakes;

(3) Household calorie intakes → preschooler calorie intakes;

(4) Preschooler calorie intakes → preschooler nutritional status.

The dependent variables in the estimating regression equations are: (1) household food expenditures, (2) household calorie intakes, (3) preschooler calorie intakes, and (4) preschooler nutritional status. The corresponding key right-hand side variables are (1) household income, (2) household food expenditures, (3) household calorie intakes, and (4) preschooler calorie intakes. Additional variables hypothesized to influence the dependent variable are used in each regression equation. Appendix 5 provides a discussion of the recursive model and the estimating equations, and the procedure to test for simultaneity of the right-hand side variables with the dependent variables.

Income is approximated by total expenditures in all regression equations. Both food expenditures and calorie intakes are derived from the 24-hour food weighing data. Income and food expenditure variables are transformed into adult equivalent units (AEU), based on individual calorie requirements. AEU

calculations explicitly account for the differences in age and gender composition of household. Therefore, the AEU approach is a refinement to the income and consumption per capita approach (Prais and Houthakker 1971; Deaton and Muellbauer 1980). The AEU estimation procedure is presented in Appendix 4.

The results of the estimated equations in the recursive model are presented in Appendix 5, Tables 5.1 through 5.5. The major findings are highlighted and interpretated as follows:

How Does Income Affect Household Food Expenditures?

Table 5.1 provides the estimated relationship between income and food expenditures.[9] Income is a statistically significant determinant of household food expenditures. Estimated at the mean level of food expenditures, the income elasticity of demand for food is 0.78, which suggests that a 10 percent increase in household income (per adult equivalent person) significantly increases food expenditures per adult equivalent person by 7.8 percent.

What Determines Household Calorie Intakes?

Income. The relationship between calorie intakes and food expenditures is estimated, and the regression results are given in Table 5.2. The estimated calorie intake elasticity with respect to food expenditures is 0.36 at the mean calorie intake level. Multiplying 0.36 with income elasticity of demand for food (0.78) gives the calorie-income elasticity of 0.28. This implies that a 10 percent

[9] No simultaneity has been detected by the Hausman test between household income (approximated by total expenditures) and food expenditures. Nevertheless, the equation has been estimated using the two-stage least squares (2SLS) method to avoid any bias that could arise when total expenditures include food expenditures calculated from the 24-hour food weighing data.

increase in income (per adult equivalent member) increases calorie intakes per person by 2.8 percent. The relatively high income elasticity of demand for food and the low calorie-income elasticity indicate that, even the low-income households spend a significant portion of increased income in upgrading the quality of their diet.

Calorie-income elasticity has also been directly estimated using the instrumental variables method. This estimate gives an elasticity of 0.286, almost identical to the 0.28 estimate derived using the two-step procedure mentioned above (obtained by multiplying 0.78 and 0.36).

Income Transfer. The positive and significant effect of VGD income transfer (as a percentage of total income) on calorie intakes indicates that the income transfer in wheat from the program results in a higher marginal propensity to consume calories than other sources of income. The effect of RR income transfer in rice (as a percentage of total income) on calorie intakes is negative, although this effect is not statistically significant. This indicates that the effect of RR income transfer in rice on calorie intakes is not different from other sources of income. The estimates of the magnitude of marginal propensity to consume out of income transfer and its implications are discussed in detail in Section 7 of this report.

Rice Price. The positive and significant coefficient of rice price relative to *atta* (whole wheat flour) price implies that as rice price increases, calorie consumption also increases, and vice versa. This relationship reflects strong cross-price substitution effects among different food items and variations in calorie-to-food

conversion factors. From various studies, Behrman and Deolalikar (1988) cite several evidences on positive food price effects on nutrient consumption, and interpret the relationship as follows: An increase in price of rice induces a sufficiently large increase in demand for other relatively low price nutritious foods (such as *atta*) and thereby increases nutrient consumption, to more than offset the direct decrease in nutrition resulting from reduced rice consumption.

This finding has important policy implications. It indicates that price subsidy on rice, as was the case in the RR program, may worsen the nutritional status of the poor, instead of improving it.[10]

Do the Children Get Their Share of Extra Calories?

Table 5.3 presents the estimated relationship between daily preschooler (aged under 5 years) calorie intakes (in adult equivalent unit) and household calorie intakes per adult equivalent unit. Since data were not collected on calorie intakes from breast milk, only fully weaned children are selected for this regression estimate. The calorie intake equation for individual preschoolers yields statistically significant positive coefficient for the household calorie intake. The estimated preschooler calorie intake elasticity with respect to household calorie intakes is 0.45. This result indicates that, at the margin, calories are not distributed equally among household members. Preschoolers get only 45 percent of their share of incremental calories in the household.

[10] A note of caution is in order regarding the interpretation and use of this finding: the positive effect of rice price on calorie intakes may hold true only if rice price is higher than atta price.

Does this mean that the children are discriminated against? Observations during the survey suggest that this is probably not the case. It has been observed that, in most households, children are not served the kind of food they would like to eat, probably because households can not afford to acquire and prepare such foods. Observations also reveal that children are usually served food only together with other family members, and they are rarely fed in-between general meals. Since the young children are not fed frequently, their dietary intakes are inadequate, although left-overs on their plates are often noticed when they are fed with other family members at long intervals. Moreover, many children do not seem to have an appetite for food, perhaps due to their frequent sufferings from various diseases.

An increase in household income improves preschooler calorie intakes, but only marginally. Multiplying the calorie-income elasticity of 0.28 by 0.45 gives the preschooler calorie-intake elasticity of 0.13 with respect to income. This low elasticity value indicates that household income must increase substantially for only a modest improvement in preschooler calorie intakes.

What Determines Preschooler Nutritional Status?

Calorie Intakes. Increased energy consumption by preschoolers improves their nutritional status, and this relationship is statistically significant (Table 5.4). The estimated elasticity of weight-for-height Z-score with respect to calorie intakes is 0.20. Weight-for-height is a short-run measure of child nutritional status, indicating acute undernutrition. This fourth and final link of the recursive system

gives the calculated short-run nutritional status elasticity of 0.03 with respect to income. This suggests that the net effect of incremental household income on the nutritional status of children is negligible in the short-run.

Table 5.5 Presents the results of the medium-term indicator of preschooler nutritional status measured in weight-for-age Z-score values, indicating both acute and chronic undernutrition. The calorie consumption effect on nutritional improvement is found to be positive and statistically significant. However, the responsiveness of preschooler nutritional status to calorie intakes diminishes in the medium-term, as reflected in the estimated calorie intake-nutritional status elasticity of 0.13.

Mother's Health. The variable related to mother's health shows interesting result. The parameter of mother's Body Mass Index (BMI)[11] is positively associated with preschooler weight-for-height, as well as with weight-for-age Z-scores, and this relationship is statistically highly significant. This indicates that healthy mothers have healthy children, probably because their good health enables them to take good care of their children.

Birth Order. Children at the lowest end of the birth order (that is, the first born) are healthier than those who are at the upper end, and this relationship is statistically significant in the medium-term, as measured by the weight-for-age indicator.

Care. A significant care-related determinant of child nutritional status (measured by the weight-for-age Z-score) indicates, when a young child is left on the ground

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[11] Body mass index (BMI) is commonly used as an indicator of adult nutritional status. BMI is defined as weight (in kilograms)/height^2 (in meters).

without any clothing while the mother performs household work, the child's health status deteriorates.

Gender. The gender difference of preschoolers (between boys and girls) has no statistically significant effect on preschooler nutritional status, both in the short- and the medium-terms.

VGD Program. The VGD program does not seem to have any significant effect on the short-and the medium-term indicators of preschooler nutritional status over and above the income transfer effect on preschooler calorie intakes. The dummy variable for VGD program is interacted with mother's awareness of child health care practices to capture the effect of training, but no significant association is found with preschooler nutritional status.

Table 8 summarizes the findings of the estimated four-stage recursive system.

DETERMINANTS OF NUTRITIONAL STATUS OF CHILDREN AGED ZERO TO 36 MONTHS

The estimated equations corresponding to the third and the final links in the recursive system exclude the breast-fed children. Therefore, the determinants of nutritional status of infants and younger children could not be identified in the model. The following analysis incorporates variables in the regression equation that might explain the nutritional status of these children. Weight-for-age Z-score is the dependent variable of the model. The results of this multivariate analysis are presented in Appendix 6, Table 6.1. The following major findings are highlighted in brief:

Table 8—Estimated elasticities and the significant parameters from the recursive system equations

Elasticity for Individual Link	Cumulative Elasticity	Description of Link	Statistically Significant Determinants
0.78	-	Household food expenditure ← Household income (expenditure)	TOTAL EXPENDITURE PER AEU (Positive); rice price relative to wheat price (negative); number of guests (negative)
0.36	0.28	Household calorie intake ← Household food expenditure	FOOD EXPENDITURE PER AEU (Positive); VGD subsidy as a percentage of income (positive); rice price relative to wheat price (positive); household size (positive); distressed area (negative)
0.45	0.13	Preschooler calorie intake ← Household calorie intake	HOUSEHOLD CALORIE INTAKE PER AEU (Positive); child's age (positive); square of child's age (negative); household head's child (positive); polluted drinking water (negative)
0.20	0.03	Preschooler weight-for-height z-score← preschooler calorie intake	PRESCHOOLER CALORIE INTAKE (Positive); mother's age (positive); mother's BMI (positive)

Source: Appendix 5, Tables 5.1 to 5.4.

- Prevalence of illness is negatively and significantly associated with the nutritional status of children. However, no simultaneity is detected (by the Hausman test) between child nutritional status and morbidity. This idicates that, illness deteriorates a child's nutritional status, but whether the causality also runs from the opposite direction is undetermined.
- It is reaffirmed in this model that better nutritional status of mother (in terms of BMI) improves child's nutritional status, and this relationship is found to be statistically highly significant.
- If a child is regularly given bath using soap, then this behavior of the caretaker has a statistically significant positive effect on the child's nutritional status. This association reflects the effects of care as well as personal hygiene.
- If a child is regularly fed green-leafy vegetables as a weaning food, than its effect on nutritional status is found to be positive and statistically significant.
- Controlling for other explanatory variables in the equation, household income per adult equivalent does not seem to influence the nutritional status of children under three years. However, through indirect ways (such as reducing child morbidity, improving mother's BMI, and providing proper weaning food) income should have a significant positive impact on child nutritional status in the longer-run.

7

Cost-Effectiveness Analysis

This section provides the cost-effectiveness analysis of the targeted interventions. First, the analysis compares the cost-effectiveness of cash versus in-kind income transfers. Second, it compares the cost-effectiveness in enhancing household food consumption through cash and in-kind income transfer. Third, within in-kind transfer, rice and wheat are compared on their respective cost-effectiveness in improving energy and protien intakes. Finally, this section provides an analysis of the cost-effectiveness of targeted food intervention in improving nutrition of mothers and children.

COST-EFFECTIVENESS OF INCOME TRANSFER

The two basic elements of the cost-effectiveness analysis of a targeted intervention are its costs and benefits. In a recent study, the Working Group on Targeted Food Interventions, chaired by IFPRI, provides estimates of cost-effectiveness of income transfers from various targeted intervention programs in Bangladesh (WGTFI 1993). The cost calculations in that study include cost of identifying beneficiaries, cost of the income transfer itself, and the administrative cost of delivering cash or commodities to the beneficiaries. Any training costs or other "development" expenditures are omitted from these "cost-of-relief" calculations. The benefits include only the income received from the programs by the beneficiaries. Any leakage of resources to non eligible persons is deducted from the calculation of income benefit.

The WGTFI study estimates that, among all existing targeted intervention programs, the Rural Maintenance Program (RMP) and the VGD program transfer income to poor households at least cost. RMP transfers cash income, while VGD transfers income in wheat. RMP delivers one taka income to a targeted household at a cost of taka 1.2. RMP delivers income relief at the lowest cost because it operates at zero leakage, and it avoids the cost of commodity handling. Among the food-based programs, VGD offers the most cost-effective income transfer mechanism. The VGD program operates at a very low leakage of 14 percent for a commodity based program. In contrast, the Rural Rationing program operated at about 70 percent leakage. The VGD program transfers one taka of income (in wheat) to an eligible beneficiary household at a cost of taka 1.5.

FOOD CONSUMPTION OUT OF INCREASED INCOME: CASH VERSUS IN-KIND TRANSFER

Cost-effectiveness of transferring income is a useful starting point in an analysis. However, a household will usually spend only a portion of an additional income on food purchases. Economists refer to this pattern as the marginal propensity to consume food (MPC). If, say, 75 paisa out of one additional taka income is spent on food, then the value of the MPC is 0.75.

Do the VGD households have a higher MPC from income received in wheat ration than that from their cash income? If they do, then this would make a food-based program more effective in providing nutrition support than an equivalent payment in cash. This proposition has been tested in this study using

an estimating regression model. The estimates are based on the lean season data when a portion of cash expenditures of several households was made out of borrowing. It is, therefore, hypothesized that the household decision to spend out of borrowed income may be different from cash-earned income.

In the estimated model, the total household income has been decomposed into cash-earned income, borrowed cash income, VGD income transfer in wheat, and other in-kind income (Appendix 7, Table 7.1). The hypothesis tested is there is no difference in MPC for different sources of income. The F-statistic is used to test whether the hypothesis is to be accepted or rejected, by running the regressions under the model and the hypothesis. A test is also performed to examine whether the coefficients of income sources are significantly different in the model.

The test results suggest that the source of income does make a significant difference in the MPC (Table 7.2). The marginal propensity to consume food out of cash income is 0.59, while the MPC from wheat income transfer is 0.92. The results of the Wald test suggest that there is no significant difference in the MPC between cash-earned income and borrowed income, while statistically significant difference is found between cash-earned income and income transfer in wheat.

The fiscal cost of increasing the value of food consumption of a household is inversely proportional to the MPC. Thus, the above estimates suggest that it will cost taka 1.69 (that is, 1/0.59) to increase food consumption expenditures by one taka through cash transfer. With income transfer in wheat, it costs only taka 1.09 to increase one taka worth of food consumption.

Due to the higher MPC from income transfer in wheat relative to cash transfer, VGD is more cost-effective than RMP in augmenting household food consumption. Including total delivery costs, VGD will require taka 1.63 to increase one taka worth of food consumption of a beneficiary household, while RMP will require taka 2.03 (25 percent more) for the same increase in food consumption.

Several studies of consumption effects of targeted food interventions in both developed and developing countries indicate that the MPC for in-kind subsidy transfer is substantially higher than that for cash income. These studies include: U.S. food stamps program (Davaney and Moffitt 1991; Senauer and Young 1986; Benus, Kmenta and Shapiro 1976); rice and cooking oil subsidy program in the Philippines (Garcia and Pinstrup-Andersen 1987); rice subsidy program in Sri Lanka (Edirisinghe 1987); and rice subsidy program in Kerala, India (Kumar 1979).

The behavioral change that causes a higher MPC for VGD wheat income transfer can be explained by economic theory[12]. The VGD program provides a fixed monthly free ration of 31.25 kilograms of wheat per household. If this ration is less than the amount of wheat the households would have consumed without the ration, then the ration is termed as "inframarginal". The ration is "extramarginal" if the ration received is greater than the amount of wheat that the recipient household consumed before its participation in the program.

If the ration is extramarginal, then the income transfer may have two effects--an income effect and a substitution effect. The pure price effect of

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[12] A more elaborate, graphical interpretation is provided in Appendix 8.

rationed wheat is captured through the substitution effect. The net effect, which also includes the income effect, may lead to an increase in wheat consumption[13], as well as increased consumption of complementary products (such as pulses), and reduced consumption of substitutes, such as rice (Kennedy and Alderman 1987).

The substitution effect, however, will take place if the resale of ration is effectively prohibited, or the resale entails a high transaction cost that decreases the implicit selling price for the ration recipients. If there is no restrictions on resale, and if the recipients have the option of selling the ration at market price, then the income transfer is equivalent to the income effect, even if the ration is extramarginal.

The VGD program does not impose any restriction on resale of the ration. Nevertheless, the survey data show that, of the total quantity of wheat lifted by the recipients, only about 19 percent has been sold by them. Perhaps, high transaction costs discourage them to sell the ration wheat. Although there are several apparent reasons for high transaction costs, this is a subject of IFPRI's forthcoming research in Bangladesh because of its important policy implications.

If the ration is inframarginal, then the income transfer has only the income effect, and the price incentive effect at the margin is lost. In this case the consumption effect of income transfer in kind should not be different from cash income transfer which, obviously, has only the income effect.

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[13] If wheat is an inferior good, then the income effect of ration will reduce wheat consumption.

During the survey, information was not collected from the VGD respondents on their wheat consumption before program participation, because such a long recall would not have provided good information. As a proxy, monthly wheat consumption of the control group is compared with the monthly VGD wheat ration of 31.25 kilograms to determine whether the ration is infra-or extramarginal. Table 9 presents the data on quantity of wheat and rice consumption by the VGD households and the control group of households. The VGD wheat ration per month is about three times the monthly average wheat consumption of the control group households during the first survey round. This clearly indicates that the ration is extramarginal.

Due to the substitution effect of the extramarginal ration (shown in Appendix 8), the VGD households consume much more wheat than that of the control group, and increase the consumption of other products due to the income and the cross-price effects of the ration. Since a large part of the consumption of other products is food by these low-income households, the net effect on food consumption is likely to be quite large. The cash income transfer, on the other hand, has only the income effect on food consumption. This explains why the MPC from extramarginal income transfer in wheat should be higher than that from the equivalent amount of transfer in cash.

There is, however, an ethical stance implicit in the above analysis: Is it morally justified to create a situation (with the extramarginal ration) so that a household changes its behavior and consumes more food? To facilitate this debate, Box 1 provides a discussion on household's own perception of welfare.

Table 9—Consumption of rice and wheat by respondent households[a]

	Foodgrain consumption	
	VGD	VGD-Control
	(kg/household/month)	
First round		
Wheat	24.76	10.37
Rice	41.99	42.76
	(kg/capita/month)	
Wheat	5.15	1.97
Rice	7.27	8.27
	(kg/household/month)	
Second round		
Wheat	16.58[b]	4.07
Rice	63.85	61.08
	(kg/capita/month)	
Wheat	3.45	0.77
Rice	11.33	11.74

Source: International Food Policy Research Institute, "consumption and Nutrition Survey, 1991/92," Bangladesh.

[a] Based on household food expenditure data.

[b] Average wheat consumption by the VGD households during the second round includes VGD wheat. The majority of the households continued to receive wheat ration, because the wheat-to-rice swap during early 1992 was only partial.

Box 1—Are Households Better-off with Cash or In-kind Transfer?

Higher food consumption from in-kind income transfers does not necessarily imply that in-kind transfers are superior to cash allocations in improving household welfare. Cash enables households to purchase non-food items, such as medicines, tubewell for safe water, soap for personal hygiene, and winter clothing for preserving body energy (that is, to prevent shivering), all of which may have substantial effects in improving health status of the family members. Cash also enables households to purchase production inputs, such as seeds and fertilizers, which have effects in increasing income, and presumably food consumption and nutrition. As microeconomic theory suggests, cash income normally yields higher satisfaction than in-kind transfer, in terms of recipient's own perception of welfare. This is shown graphically in Appendix 8.

However, a household usually consists of several members. In the traditional approach to microeconomic theory, all members of the household are assumed to have the same preference, that is, the household is considered to act as one. But in reality, individual household members will most likely have different preferences. Studies by sociologists and anthropologists suggest that men and women make different choices in spending income under their control. Generally, men spend some of their income on goods for their own personal consumption (such as cigarettes), while women are more likely to purchase goods for children and for general household consumption (Haddad, Hoddinott and Pena 1992). Thomas (1992) found that, in Brazil, an additional income in the hands of women will raise the share of the household budget spent on health, education, and household services three to six times more than if the additional income is in the hands of men. Several studies document evidence that, in both Asia and Africa, income controlled by women is associated with higher household food expenditures and calorie intakes than male controlled income (Guyer 1980; Garcia 1991; Haddad and Hoddinott 1991; von Braun and Kennedy 1992). These findings suggest that, targeting cash income transfer to households where women control income will likely to improve welfare of household members.

NUTRITION AND COST-EFFECTIVENESS IMPLICATIONS OF WHEAT-TO-RICE SWAP

During early 1992, wheat-to-rice swap was introduced in the PFDS targeted food distribution channels. The swap was one-to-one, that is, the VGD beneficiaries received the same quantity of 31.25 kilograms of rice ration per month instead of wheat. During the second round of IFPRI household survey (February 1992), several VGD respondent households received rice ration, while others continued to receive wheat. Fortunately, this enables the present study to compare the effects of wheat-to-rice swap in the same season for the rice and wheat recipient households.

Table 9 incorporates the average quantity of rice consumption by the sample households during the second survey round. Higher consumption of foodgrain during the second round compared to the first round data reflects the seasonal differences in consumption. The first and the second rounds of survey represent the lean-and the peak-seasons, respectively[14].

The one-to-one wheat-to-rice swap indicates that the rice ration for VGD households is inframarginal. The entitlement of 31.25 kilograms of rice constitutes only about 51 percent of the average quantity of rice consumed by the control group of households. This suggests that the consumption effects of income transfer in rice should be equivalent to the income effect of the transfer only. The income transfer in wheat ration may have a higher MPC than rice ration due to the substitution effect of the extramarginal wheat ration. This proposition is

[14] The peak-season data were collected after the harvest of Aman rice crop, the largest rice crop in Bangladesh in terms of production.

empirically tested in the following analysis for the marginal propensity to consume calorie and protein from the VGD income transfer in rice and wheat.

The test procedure followed is similar to the test performed earlier for the differences in MPC in the sources of income. The test results are presented in Appendix 7, Table 7.4. As expected, the test results suggest there is no statistically significant difference between the MPC from cash income and income transfer in rice. However, statistically highly significant differences in the MPC are found between cash income and income transfer in wheat ration, as well as between income transfers in rice and wheat rations.

The results suggest that one taka of income transfer in wheat per day would increase daily per capita nutrient intakes by 401 calories and 13 grams of protein (Appendix 7, Table 7.3). The wheat-to-rice swap dramatically reduces the cost-effectiveness of the VGD program in improving nutrient intakes. Daily per capita nutrient intakes increase by 194 calories and 5 grams of protein from a one taka income transfer in rice per day.

Compared to rice ration, the rate of increase in protein consumption from wheat ration is relatively much higher than the rate of increase in calorie consumption. This is not only because wheat has a higher protein content than rice, but also it apparently changes the diet pattern so the protein supply in the diet from complementary food items increases[15]. This makes wheat a better ration commodity than rice in alleviating the protein-energy malnutrition (PEM).

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[15] In Bangladesh, *rooti*, made of whole wheat flour is usually eaten with more concentrated *dal* (pulses) while diluted *dal* is eaten with rice. Table 1.4 in Appendix 1 of this report shows that the consumption of pulses by the VGD households is higher than that by the control group households. Pulses are a rich source of protein.

Due to the one-to-one swap, the program cost increases substantially because rice price is higher than wheat price in both domestic and international markets. Although one-to-one swap increases the real incomes of the recipeiant households, the analysis suggests that the wheat-to-rice swap actually worsens the household nutritional status, instead of improving it.

COST-EFFECTIVENESS OF IMPROVING NUTRITION OF MOTHERS AND CHILDREN

The analyses in this study have shown that the preschool children are at greatest nutritional risk, followed by mothers. The multivariate analysis in the preceding section suggests that mother's health status (in BMI) has statistically highly significant positive effect on child nutritional status. In the recursive model, however, only the direct effects of income through the chain of food and calorie intakes at different stages have been captured. The effects of interactions, particularly, the effect income transfer has on mother's health, and to what extent that effect influences the nutritional status of children, could not be measured in the recursive system.

In this section, an attempt is made to assess the total effects of income transfer in improving nutrition of children and their mothers. For this purpose, a five-equation model is estimated, and simultaneously solved for the base solution. Then, in a model simulation exercise, the value of income transfer is changed by one taka and the model is solved again. The results of the five estimated equations for children and their mothers are presented in Appendix 9, Tables 9.1

through 9.5. From the simulation results, fiscal costs of improving individual nutrition are estimated, and the results are presented below.

- With VGD income transfer in wheat, it costs taka 22.23 per month to increase mother's daily intakes by 100 calories. The cost increases to taka 64.68 per month to increase the daily intakes of preschoolers by 100 calories. The higher costs for preschoolers compared to mothers reflect the uneven distribution of the average calorie increment at the household level.

- The costs of achieving the same level (100 calories) of increase through other sources of income (that is, without income transfer in wheat) are taka 69 and taka 202 per month, respectively, for mothers and preschool children. The analysis presented earlier indicates that, had the VGD wheat ration been inframarginal (or, if there was no transaction cost), then the costs of achieving the same increases in calorie intakes would have been as high as it would cost through other sources of income. The results of the analysis on the effects of wheat-to-rice swap implies that the swap would require similar costs as from other sources of income to improve the nutrition of mothers and children.

- How much does it cost to achieve 100 percent calorie adequacy of the low-income individuals through VGD-like income transfer in wheat? These costs are calculated based on the average calorie adequacies of the control group members. The results suggest that, through VGD-type income transfer, it costs taka 94 per month to increase the average calorie adequacy per adult equivalent control group member to 100 percent. The current level of VGD income transfer provides about 60 percent of this costs. However, the costs increase substantially for mothers and preschool children due to the combined effects of their relatively

low adequacy levels, and their reduced shares of incremental household level calories. The monthly costs of raising calorie adequacies to 100 percent level are taka 114 for each mother, and taka 266 for each preschool child of the control group households.

■ In this analysis, the nutritional status of mother is measured by BMI, and for preschool child, by weight-for-height Z-score. A BMI of 18.5 is considered normal for adult male and female (James, Ferro-Luzzi and Waterlow 1988). A Z-score value of zero indicates that a child has normal nutritional status. For the control group of households, the average mothers' BMI is 17.59 (the median was 17.56) and the average weight-for-height Z-score value of the preschoolers is -1.12. The estimates suggest that to raise the average nutritional status of mothers and preschoolers of the control group households to normal levels, the monthly costs are taka 557 for each mother and taka 1,292 per preschooler through VGD-like income transfers.

■ The above results suggest that the income transfer in wheat from VGD program is relatively more cost-effective than other sources of income in improving calorie intakes of the program beneficiaries. The program substantially improves household food security, and is quite effective in increasing mothers' calorie intakes. However, as the regression results suggest, each additional pregnancy reduces mother's BMI to a large extent, and this negative relationship between the number of pregnancies and mother's health status is statistically highly significant (Appendix 9, Table 9.3). Thus, controlling for pregnancies, the net gains in nutritional status from increased calorie intakes are minimal.

- For preschool children, high degree of leakages occur in two stages: (1) as preschoolers largely fail to capture their share of increased calorie at the household level; and (2) when increases in preschooler calorie intakes are not translated into improved nutritional status, mainly because of high prevalence of sickness.
- The analysis suggests, to improve the health status of children, food intervention programs alone are not cost-effective, in spite of their potentials of significantly improving household food security.

8

Conclusion

An effort has been made in this study to assess the food consumption and nutritional effects of the two large targeted food interventions in Bangladesh: the Rural Rationing and the Vulnerable Group Development programs. At the onset of the study, the underlying assumption was that the economic gains from these programs would improve food consumption and nutrition of the beneficiary household members.

The RR program has largely failed to conform with the assumption. As documented in an earlier IFPRI study, the operational performance of the program was unsatisfactory. For a minimal transfer of income to an eligible beneficiary the government incurred a large cost. The nutritional effects of the RR program are even more discouraging, as the present study indicates. The direct static comparisons with the control group, complemented by the multivariate analysis give a notion that the RR program might have had a negative influence on nutritional status of the program participants, although these evidences are not strong enough to be statistically significant. However, inference can be drawn indirectly from a statistically significant relationship which indicates that the price subsidy on rice ration in the RR program might have worsen the nutritional status of the members of the households participating in the program.

In contrast, the income transfer from the VGD program significantly adds to income of the beneficiary households, which in turn enhances household food and nutrient intakes. The findings of this study indicate that the success of the

VGD program in improving household food security is mainly due to the form of income transfer in wheat, more than anything else. Indeed, the net nutritional effect of the recent wheat-to-rice swap in the VGD program has been negative, with everything else remaining unchanged, including the quantity of ration.

Two characteristics of wheat have made it a better self-targeting commodity for the VGD program than the equivalent value in cash or the same quantity of rice: (1) the share of wheat in the food budget of poor families is relatively small, hence the size of ration could be made substantially "extramarginal" at a relatively low program cost; and (2) the resale of wheat by the program beneficiaries apparently entails a high transaction cost. Rice, on the other hand, has the opposite characteristics.

The recent trends in Bangladesh rice production indicate that the country might emerge as a surplus rice producer in the near future, if has not already. However, the poor section of the population, millions of them, are too poor to capture the gains from rice surplus or self-sufficiency. Due to their inadequate purchasing power, they lack access to enough food and thus remain seriously underfed (Box 2). Given this situation, the expansion of effective targeted interventions (such as the VGD program) or alternative new programs for the poor become central to improving household food security in the short-run. The findings of this study stress that wheat should be distributed for such interventions, instead of rice, to alleviate the protein-energy malnutrition at a least cost.

The results of this study indicates, although increased income, and calorie consumption at the family level are statistically significant determinants of child

Box 2 -- The Agony and Privation of a Poor Family

Abdul Karim, about 35, is the head of a landless household. He lives with his wife, Ayesha, and their three children in Puthimari village of Chilmari Thana, one of the most distressed areas of Bangladesh. Abdul's household is among the many severely poor households in the village that were not covered by any of the government intervention programs. The household was included in the control group of IFPRI's consumption and nutrition survey.

Abdul's one-room house, with walls made of Kash (a kind of tall, wild grass) and bamboo, and a straw roof, is too small for his family. It is clear that the household is in extreme poverty. The severity of malnutrition that the family members are suffering from is evident from their skeleton-like features.

IFPRI field investigators Zobair and Farzana interviewed Abdul and Ayesha. "You can see our miserable condition. Yet, we are not included in any of the government programs". Abdul said bitterly. "It is true that most of them who are getting ration are also poor, but none of them are as needy as we are," Abdul asserted.

"Two days ago, I worked on a neighbor's land, weeding his radish field. He gave me five taka, and a meal of rice and dal for the whole day's work". Abdul continued, "Yesterday, I went to him again, but he offered me only three taka and a meal. I accepted and worked from morning till evening.

The day we visited them, nobody in the family could find any work. Abdul spent his eight taka in buying about a kilogram of wheat. Ayesha was frying the wheat in an earthen pot. "I soaked the wheat in salt-mixed water before frying. The wheat becomes hard and brittle after frying. This fried wheat is all we have for today's meal. From this, I have to save some for tomorrow also," Ayesha said. Farzana asked her why they didn't crush the wheat to make atta (whole wheat flour). "With atta from this wheat I could make only a few rooti, which the children would eat in no time because they are so hungry. Instead, we can chew the fried wheat for a long time," Ayesha explained. "I know that I am cheating my own children," she sobbed, "But what can I do? We don't have money to buy more wheat or rice. Nobody wants to hire me or my husband for work because we are so weak. But if we can't find work, then we can't eat, and without eating we will become weaker".

Abdul nodded, "She is right, Aswin and Kartik (the lean season) are the most difficult months. Many children in this area die during this time. They are so weak that even simple diseases kill them," he said, looking at his own children. "But things will improve after a month during Aman rice harvest. Everybody will get work. Ayesha will parboil paddy and husk rice in farmers' houses," Abdul tried to console himself.

"But what will happen to us next? The river will probably take away our house next year," Ayesha expressed her anxiety, and then maintained, "We were not this poor when we got married. We had some land, and we produced enough rice for our small family during that time. But one night, there was a big land erosion and the rakkushi (a legendary animal, like a dragon) river swallowed our land. Except this house, we have nothing left now. Last month, I sold my gold nose pin to a neighbor for one-fourth the price my husband paid for it. With that money we bought some rice and wheat".

Abdul sold a mango tree early that month for only 100 taka. "The tree could easily fetch 500 taka. Big and sweet mangoes used to grow on that tree. But the man who bought the tree, cut it for firewood, because it could go into the river during the next flood. You see, the river is the cause of all our misery," Abdul concluded.

The interview was over, and we were about to leave Abdul's house. At that time, Biplab, Abdul's eight-year old son, came running with a large and beautiful water hyacinth flower in his hand. He gave the flower to Farzana and said to her shyly, "Please come again". Farzana had managed to hold her tears during the interview. She could not hold them any longer.

nutritional status, their magnitude of impact is minimal. Since a large "leakage" occurs between increases in household level calorie acquisition and child calorie intakes, the distribution of a low-cost nutrient-dense weaning food may improve cost-effectiveness of intervention for improving child nutrition.

The other leakage occurs when increased child calorie intakes are only partially translated into his or her growth. At this link, the child's sickness probably has the most deterrent effect by lowering the body's absorption capacity of nutrients. Development of rural health infrastructure, and medical supplies and services is crucial in strengthening the nutrient intake-health status linkage. As identified in this study, several significant determinants of child nutritional status relate to caring behavior. The gains from improved household food security and developed health facilities can be effectively brought to a child by proper caring practices. Someone in the family has to prepare the right kind of food for the undernourished child, and feed him or her at an optimum frequency. When the child becomes sick, someone has to recognize that the child needs care and attention, provide the needed care, and bring the child to a health clinic, if necessary. Without such caring practices, the undernourished child is likely to remain undernourished in spite of improved household food security and developed health facilities. Nutrition education and training programs, if appropriately designed, have important role to play in convincing the mother or other caretakers to improve their caring practices for children.

A supplementary IFPRI study is currently underway in Bangladesh that attempts to determine why do some rich families have malnourished children,

while some poor families have children with good nutritional status. The study particularly focuses on child caring behaviors in determining positive and negative deviances in child nutritional status. It is hoped that the study would generate ideas for more appropriate interventions.

The findings suggest that mother's health has a strong positive influence on child's nutritional status. Thus, it is stressed that, rather than focusing on malnourished children in isolation, it would be more cost-effective to reach them through interventions that include the children as well as their mothers for improving their health status. This study demonstrates that the VGD program substantially improves food security of recipient households, and is quite effective in promoting mothers' nutrition.

This study suggests two modifications of the VGD program for extending the program's nutritional benefits to children in a cost-effective way: (1) provision of a low-cost nutrient-dense weaning food for households with malnourished young children, and (2) proper nutrition counseling and training with particular emphasis on improved caring practices. The effectiveness of these modifications should be pilot-tested, and then implemented on a larger scale.

Appendix 1

Supplementary Tables

Table 1.1—Proportion of total household expenditures spent on major commodity groups

Commodities	RR	RR Control	VGD	VGD Control	All
			(taka/month)		
Total expenditure per capita	250	263	240	233	254
			(percent)		
Food	75.2	74.5	75.6	74.0	75.0
Housing	2.9	3.0	3.2	3.2	3.0
Fuel	3.6	4.3	4.7	4.7	4.2
Clothing and footwear	1.8	2.3	2.3	2.2	2.1
Medical services and medicines	4.1	3.5	2.2	2.7	3.4
Education	0.4	0.2	0.3	0.2	0.3
Ceremonials/Entertainment	3.8	2.4	4.2	2.5	3.3
Tobacco	1.6	2.2	1.6	2.4	1.9
Durable goods	0.0	0.0	0.0	0.0	0.0
Other goods and services	6.5	7.6	5.8	8.1	7.2
Total	100.0	100.0	100.0	100.0	100.0

Source: International Food Policy Research Institute, "Consumption and Nutrition Survey, 1991/92," Bangladesh.

Note: Components may not add to totals because of rounding.

Table 1.2—Sources of food expenditures

Category	RR	Control	VGD	Control	All
			(Taka/person/month)		
Food expenditure	183	193	177	166	172
			(percent)		
Purchased food	65.2	78.4	51.3	73.6	67.6
Own produced/collected	9.0	9.8	5.5	8.2	7.5
Wage in food	8.0	7.3	9.5	8.8	7.7
Borrowed food	0.9	0.6	0.8	0.6	0.9
Ration	13.1	0.0	30.7	0.0	11.5
Gift in food	3.8	3.8	2.2	8.8	5.7
Total	100.0	100.0	100.0	100.0	100.0

Source: International Food Policy Research Institute, "Consumption and Nutrition Survey, 1991/92," Bangladesh.

Note: Components may not add to totals because of rounding.

Table 1.3—Proportions of food budget allocated to various foods[a]

Category	RR	RR Control	VGD	VGD Control	All
			(taka/month)		
Per capita food expenditure	183	193	177	166	172
			(percent)		
Rice	59.3	51.5	53.3	49.3	54.7
Wheat	6.5	11.7	19.2	16.3	11.5
Other cereal	0.0	0.0	0.1	0.0	0.0
Pulses	1.8	2.2	2.5	2.3	2.1
Oil	2.3	2.5	1.7	2.1	2.2
Salt	0.8	0.8	0.6	1.0	0.8
Fish	7.4	9.5	6.6	7.9	8.1
Meat	0.6	0.4	0.0	0.2	0.4
Egg	0.1	0.1	0.2	0.1	0.1
Potatoes	1.3	1.7	0.9	1.5	1.4
Vegetables	11.7	10.0	7.8	11.1	10.1
Onion	0.5	0.7	0.4	0.5	0.5
Spices	6.8	8.2	6.1	6.8	7.2
Sugar and gur	0.2	0.1	0.2	0.1	0.2
Milk	0.2	0.5	0.1	0.6	0.3
Fruits	0.5	0.2	0.3	0.2	0.3
Other food	0.1	0.0	0.0	0.0	0.0
Total	100.0	100.0	100.0	100.0	100.0

Source: International Food Policy Resarch Institute,"Consumption and Nutrition Survey, 1991/1992," Bangladesh.

[a] Estimate of food expenditure is based on [illegible] weighing data.

Table 1.4—Quantity of food acquisition per capita[a]

Item	RR	RR Control	VGD	VGD Control	All
			(grams/month)		
Rice	9,609	8,835	7,271	8,270	8,856
Wheat	1,250	1,651	5,146	2,002	2,253
Other cereal	51	000	0	0	19
Potatoes	205	275	114	227	215
Pulses	112	133	138	125	126
Vegetables	977	913	641	725	878
Fish	317	368	301	303	335
Meat	15	16	24	14	17
Egg	44	76	78	100	65
Salt	466	514	556	502	505
Oil	95	111	99	109	103
Milk	62	73	59	113	66
Sugar	116	148	147	158	136
Onion	86	107	95	101	96
Spices	126	151	157	142	143
Fruit	202	187	522	288	264
Other food	25	89	1	121	47

Source: International Food Policy Research Institute, "Consumption and Nutrition Survey, 1991/92," Bangladesh.

[a] Based on household food expenditure data.

Table 1.5—Calorie composition by food groups[a]

Category	RR	Control	VGD	Control	All
			(kcal/day)		
Calorie intake per capita	1,535	1,554	1,624	1,513	1,561
Calorie intake per AEU	2,116	2,127	2,161	2,077	2,134
			(percent of total calorie intake)		
Rice	75.70	69.27	65.62	65.13	70.93
Wheat	9.13	15.61	24.97	21.17	15.16
Other cereal	0.01	0.01	0.11	0.01	0.03
Pulses	1.55	1.79	1.67	1.64	1.68
Oil	1.75	2.05	1.37	1.97	1.81
Fish	2.03	2.39	1.32	1.71	2.03
Meat	0.07	0.07	0.00	0.05	0.05
Egg	0.02	0.01	0.03	0.01	0.02
Potatoes	0.68	0.89	0.38	0.73	0.71
Vegetables	7.47	6.05	3.26	6.01	5.94
Onion	0.05	0.08	0.05	0.06	0.06
Spices	1.05	1.36	0.83	1.11	1.14
Sugar and Gur	0.18	0.14	0.19	0.08	0.16
Milk	0.06	0.17	0.03	0.21	0.10
Fruits	0.24	0.11	0.17	0.10	0.17
Other food	0.01	0.00	0.00	0.00	0.01
Total	100.00	100.00	100.00	100.00	100.00

Source: International Food Policy Research Institute, "consumption and Nutrition Survey, 1991/92," Bangladesh.

[a] Based on 24-hour food weighing data.

Table 1.6—Cost of calorie*

Item	Cost
	(taka/thousand kcal)
Wheat	2.64
Rice	3.35
Oil	5.67
Sugar	5.70
Pulses	5.72
Other cereal	7.05
Potatoes	9.03
Vegetable	10.91
Milk	16.01
Fruit	22.15
Fish	22.21
Egg	29.08
Spices	29.18
Other prepared food	35.92
Onion	43.05
Meat	59.45

source: International Food Policy Research Institute, "Consumption and Nutrition Survey, 1991/92," Bangladesh.

* Based on 24-hour food weighing data.

Appendix 2

Access to VGD Program

The probabilities of access to the VGD program by rural households that meet some or all selection criteria are estimated in this study from the survey data. Since most of the sample households are landless, the selection criterion of landlessness is not considered in the estimation. A logit model is used to determine the factors that enhanced or reduced the probability of a household's access to the program. The results of the logit estimates are presented in Table 2.1. The conditional probabilities are calculated from the statistically significant coefficients of the model and are interpreted as follows: (a) A low-income rural household with no regular earning member has a 48 percent probability of gaining access to the VGD program; (b) the probability increases to 75 percent for a female-headed household; and (c) if the household has no regular earning member, and is female-headed, then the probability of that household in obtaining access to the program increases to 91 percent.

Table 2.1—Determinants of access of poor households to VGD program (Logit estimate)

Explanatory Variables	Estimated Parameters	t-Values
Constant	1.697	2.50**
Household income per AEU	-0.0002	-0.33
Number of Child bearing age woman	0.367	1.39
Ratio of children to total Family member	6.067	-5.92***
Education of Household head	0.079	1.41
Ratio of earning member to total family member	-1.224	-2.09**
Female headed Household dummy (1=female headed households)	2.709	5.09***

Note: Dependent variable: 1 for VGD beneficiary households and 0 for others. The estimated parameters are used to calculate the probabilities.

*** Significant at the 0.01 level.
** Significant at the 0.05 level.

Appendix 3

Sampling Procedure

The sampling for this study could be designed one of two broad ways--it could be nationally representative or not. For a nationally representative sample, a two-stage sampling procedure could be used. In the first stage, several clusters are chosen at random from a national universe. These clusters might be thanas, for example. In the second stage the sampling universe is defined as all inhabitants of these clusters. Alternatively, the sampling universe might be all members of a certain group, for example, all beneficiaries of the VGD program in the clusters. A random sample of these program beneficiaries would then be drawn for each cluster. The results can then be aggregated to be nationally representative of all participants in that program.

However, if the first stage (selection of clusters) is designed to ensure adequate variations in factors, such as distress-proneness, developed and un-developed areas, and seasonality, while still retaining national representativeness, then the sample size will have to be very large and the cost of survey prohibitively high (Alwang 1991). Therefore, it was decided that the first stage sampling should focus on achieving adequate variation in the factors that might affect consumption and nutrition, and not on national representativeness.

Eight thanas, two in each of the four divisions of the country, were selected for the survey. Four of the thanas were selected from distressed areas and the other four from non-distressed areas. The four distressed thanas have been identified using the World Food Programme's distress map where thanas are identified by distress factors (Figure 2

in Section 4). Two distressed thanas and two non-distressed thanas were selected from infrastructurally developed areas. The other four thanas were selected from relatively poor infrastructure locations. From these eight thanas, eight villages were selected for the survey. The operational performance of the Rural Rationing (RR) program was unsatisfactory, while the Vulnerable Group Development (VGD) program is known to be performing well. Therefore, to capture the potential nutritional impact of the RR program, eight villages were chosen from the eight selected thanas, where the RR program was operating relatively well.

A census (100 percent of the households) of the eight villages was conducted. All RR and VGD beneficiary households were identified from the census data. Non-beneficiary households comparable to RR and VGD households in socio-economic status were also identified. Thus, the households were classified into four strata--RR, VGD, a comparable non-beneficiary households, and all other households. From each stratum (such as, all VGD households in the selected village clusters) the random selection of households (with adequate variations) at the second stage would mean that the sample would be representative of each broad type of village. However, the sample would not be nationally representative because the number of clusters (villages) chosen was small.

The basic guideline for choosing the stratum sample size can be derived from statistical theory. Assuming the population is normal, the required sample size, N can be determined by the following equation:

$$N = [f(Z)\, s/D\, \bar{x}\,]^2, \qquad (3.1)$$

where f(Z) is the number of standard deviations that correspond to the confidence level Z, s is the standard deviation of the variable in question, x is its mean, and D is the desired

precision of the estimation of the population mean. For any value of D, the required N can be calculated to have a probability of Z that the sample mean will be within the desired precision of the true value (Alderman and von Braun 1984).

A total of 3,194 households were surveyed in the 100 percent census of the eight selected villages. The census data provide information on household size, and total household expenditures during the past one month from the census date. Per capita expenditure is thought to be the most important variable in selecting the stratum sample size. Therefore, for each stratum, the mean of per capita expenditure per month ($\bar{x}$) was calculated, from census data and its standard deviation (s) was estimated. Using the formula in equation (3.1), the optimal strata sample sizes are 208, 125, and 234 for RR, VGD, and control group of households, respectively, derived as follows:

	RR	VGD	Control
Mean per capita expenditure ($\bar{x}$) taka/month	279	257	298
D = 0.05			
5% of mean ($D\bar{x}$)	14.0	12.9	14.9
Standard deviation (s) of x	101	72	114
t(Z) = 2			
Sample size (N)	208	125	234

For each stratum, a random sample of households was drawn from each village, so that the sum of the randomly drawn village samples was equivalent to the total stratum sample size. The sample size for each village was in proportion to total number of

households in that village. The VGD sample was drawn only from the four distressed villages because the program heavily concentrates in distressed areas. During the survey, a few households were dropped from the sample (8 from RR and 8 from VGD) for various reasons, while 2 households were added to the control group sample. Thus, a total of 553 households (200 RR, 117 VGD, and 236 control) were surveyed. Table 3.1 presents the list of survey villages and respective sample size for each program and control groups.

Table 3.1—Locations and sample size of household nutrition survey, first survey round

Village	Thana	Sample size			
		RR	VGD	Control	Total
		(number of households)			
Nurpur	Hobiganj	22	-	24	46
Jhapua	Barura	23	-	30	53
Dolomba	Adamdighi	26	-	22	48
Ramnagar	Harinakundu	24	-	18	42
*Purba Kallan	Kurigram	24	21	40	85
*Puthimari	Chilmari	35	29	41	105
*Char Shamail	Shibchar	18	39	36	93
*Chak Haricharan	Daulatpur	28	28	25	81
Total		200	117	236	553

Source: International Food Policy Research Institute,"Consumption and Nutrition Survey, 1991/1992," Bangladesh.

*Distressed areas.

Appendix 4

Estimation of Energy Requirements

Estimates of individual energy requirements in this study are based on the methodology provided in FAO/WHO/UNU Expert Consultation (1985), and James and Schofield (1990). Energy requirements need to be calculated for individuals in each sex and in specific age groups. The principal components of energy requirements are Basal Metabolic Rate (BMR), weight, age, sex, and level of physical activity. BMR is measured under conditions of absolute rest in the fasting state. Equations for calculating BMR from body weight of different age and sex groups from 10 years and above are listed in Table 4.1.

The total daily energy requirement (R) of an individual (aged 10 years and above) is calculated as:

$$R = (BMR \times PAL) + PLF \qquad (4.1)$$

Individual BMR is determined from actual body weight, using the anthropometric data collected in the survey. Although physical activities of individual household members were recorded in the survey, the information could not be processed in time for this report. Therefore, a rather crude method of estimation of the physical activity level (PAL) is adopted. Table 4.3 presents PALs for the average physical activity of each age and sex group in rural areas of less developed countries, as provided in James and Schofield (1990). These PAL values are used in equation (4.1) to estimate the individual energy requirements.

For a woman who is pregnant or lactating or both, the pregnancy/lactation factor (PLF) is included in equation (4.1) to estimate her energy requirements. Three values of PLF allowances are adopted from James and Schofield (1990): allowance for pregnancy, 285 kcal/day; for lactation, 500 kcal/day; and for both, 785 kcal/day.

Energy requirements for children from birth to 9+ years are given in James and Schofield (1990) in kilocalories of (kcal) per kilogram of body weight. Table 4.2 provides energy requirements for children. Energy requirement for a child is calculated by multiplying the child's actual body weight by requirement per kilogram.

Individual calorie intakes are measured in this analysis by a combination of 24-hour food weighing and recall (for food consumed outside home) method. Using the estimates of individual calorie requirements, calorie adequacy is computed for each individual as follows:

$$\text{Individual calorie adequacy (\%)} = \frac{\text{Calorie intake of individual}}{\text{Calorie requirement of individual}} \times 100 \qquad (4.2)$$

In food consumption and nutrition analysis, it is appropriate to use nutritional scales to adjust for the effects of household composition. In this analysis, energy intake per adult equivalent is calculated. Each family member is indicated as a fraction of an adult male equivalent consumption unit based on the calorie requirements. Actual calorie intake of an individual divided by this fraction gives the adult equivalent calorie intake for that individual. Specifically:

$$\text{Adult equivalent calorie intake} = \frac{\text{Actual calorie intake of individual}}{\text{(Calorie requirement of individual/Calorie requirement of an adult male)}} \qquad (4.3)$$

An estimated daily calorie requirement of 2,714 kilocalories per adult male equivalent unit is adopted in this analysis as a benchmark.

Table 4.1—Basal metabolic rate (BMR) for adolescents and adults

Age Range	Male	Female
(years)	(kcal per day)	
Adolescents		
10-17+	17.5W*+ 651	12.2W + 746
Adults		
18-29+	15.3W + 679	14.7W + 496
30-59+	11.6W + 879	8.7W + 829
>60	13.5W + 487	10.5W + 596

Source: Report of a Joint FAO/WHO/UNU Expert Consultation, "Energy and Protein Requirements", World Health Organization, Technical Report Series 724 (Geneva 1985).

*W is the average weight in kilograms.

Table 4.2—Energy allowance for children aged under ten years

Age	Male	Female
(years)	(kcal per kg of body weight)	
0+	109	109
1+	108	113
2+	104	102
3+	99	95
4+	95	92
5+	92	88
6+	88	83
7+	83	76
8+	77	69
9+	72	62

Source: W.P.T. James and E.C. Schofield, "Human Energy Requirements: A Manual for Planners and Nutritionists", published for FAO by Oxford University Press (Oxford 1990).

Table 4.3—Allowances for physical activity expressed in terms of PAL values

Age Group	Male	Female
(years)	(PAL value)	
Children		
0-9+	Children's energy needs are based on intake related to body weight	
Adolescents		
10+	1.76	1.65
11+	1.72	1.62
12+	1.69	1.60
13+	1.67	1.58
14+	1.65	1.57
15+	1.62	1.54
16+	1.60	1.52
17+	1.60	1.52
Adult[a] 18-59+	1.86	1.69
Elderly[b] (>60)	1.51	1.56

Source: W.P.T. James and E.C. Schofield, "Human Energy Requirements: A Manual for Planners and Nutritionists", published for FAO by Oxford University Press (Oxford 1990).

[a] Assumed 75 percent moderate and 25 percent heavy activity levels for adults in rural LDCs.

[b] For elderly (>60 years) assumed 100 percent light activity levels.

Appendix 5

The Recursive Model and the Results of the Estimated Regression Equations

It is usually assumed in a household modeling that household allocation decisions are made simultaneously, and hence, the model is formulated in a system of simultaneous equations, solved and put into its reduced form. However, these reduced form equations do not allow to draw any conclusions on the specific impact of critical structural variables at each particular stage in the process, in this case, from household income to preschooler nutritional status. In order to avoid this problem, Bouis and Haddad (1990a) suggest a recursive system, where the endogenous variables are determined sequentially rather than simultaneously. Following Bouis and Haddad, a recursive system has been formulated and the equations estimated in this study to link the following stages:

FOOD EXPENDITURES	=	f_1 (INCOME, other variables)	(1)
HOUSEHOLD CALORIES	=	f_2 (FOOD EXPENDITURES, other variables)	(2)
PRESCHOOLER CALORIE INTAKES	=	f_3 (HOUSEHOLD CALORIES, other variables)	(3)
PRESCHOOLER NUTRITIONAL STATUS	=	f_4 (PRESCHOOLER CALORIE INTAKES, other variables)	(4)

At each stage in the recursive system, the key variables on the right-hand side of each individual equation are tested for simultaneity with the dependent variable. If the null hypothesis of exogeneity of the right-hand side variable is rejected for any equation, then the equation is estimated using the two-stage least

squares (2SLS) technique. The additional right-hand side variables used in each estimating equation are presented in the regression results in Tables 5.1 through 5.5.

The Hausman test is used to test for simultaneity. The test procedure has been adapted from Bouis and Haddad (1990b) as follows:

The two-step test procedure is explained with the example from equation (1) above, where it is necessary to test whether income, on the right-hand side, is determined simultaneously with food expenditures, the dependant variable. First, income is regressed on all other variables on the right-hand side of equation (1) plus at least one exogenous instrument, for example, area of owned land. Second, equation (1) is regressed as originally specified, but predicted income is included, obtained from step one, as an additional variable (both income and predicted income are included on the right-hand side). If the coefficient on predicted income is significantly different from zero (as determined by the t-test), then the null hypothesis of exogeneity is rejected. This completes the Hausman test. If the null hypothesis of exogeneity is rejected, equation (1) is estimated using predicted income in place of income, using the 2SLS technique.

Table 5.1—Relation between household food expenditures and total income

Explanatory Variables	Estimated Parameters	t-Values
Constant	1.510	0.23
Log income per AEU (including subsidy)	6.950	5.94***
VGD subsidy as a percentage of income	0.925	0.62
RR subsidy as a percentage of income	-4.295	-0.62
Rice price relative to wheat price	-7.102	-2.14**
Household size	0.020	0.23
Number of guests	-1.846	-4.10***
Distress area dummy (1=distress area)	-0.169	-0.42
F-statistic	34.74***	
$\bar{R}^2$	0.59	

Note: Dependent variable is daily household food expenditure per AEU.

***Significant at the 0.01 level.
** Significant at the 0.05 level.

Table 5.2—Relation between household calorie intakes and food expenditures

Explanatory Variables	Estimated Parameters	t-Values
Constant	-975.537	-2.37**
Log household food expenditure per AEU	779.119	18.25***
VGD subsidy as a percentage of income	794.193	4.80***
RR subsidy as a percentage of income	-737.487	-0.87
Rice price relative to wheat price	1,156.026	3.75***
Household size	21.955	2.24**
Number of guests	-37.290	-0.80
Distress area (dummy)	-128.827	-2.49***
F-statistic	52.88***	
$\bar{R}^2$	0.40	

Note: Dependent variable is daily household calorie intake per AEU.

*** Significant at the 0.01 level.
** Significant at the 0.05 level.

Table 5.3—Relation between preschooler calorie intakes and household calorie intakes

Explanatory Variables	Estimated Parameters	t-Values
Constant	-6409.536	-3.74***
Log household calorie intake per AEU per day	798.040	3.66***
Log household size	13.451	0.10
Child's age in month	64.052	3.15***
Square of child's age in month	-0.501	-2.14**
Sick days	0.011	0.06
Sex (dummy)[a]	-36.013	-0.54
Birth order[b]	-15.938	-0.99
Number of guests	-66.093	-0.73
Household head's child (dummy)[c]	452.129	2.73***
Working mother (dummy)[d]	98.267	1.22
Polluted drinking water (dummy)[e]	-130.439	-1.78*
Left without cloth (dummy)[f]	6.791	0.10
Distress area (dummy)	-100.170	-1.40
VGD dummy	-51.119	-0.51
F-statistic	7.05***	
$\bar{R}^2$	0.29	

Note: Dependent variable is daily preschooler calorie intake in AEU.

[a] 1 for male and 0 for female.
[b] 1 represents the first born, 2, second born, and so on.
[c] 1 if household head's child.
[d] 1 if the mother is engaged in work outside home.
[e] 1 if the drinking water is polluted.
[f] 1 if the child is left on the floor without cloth.

*** Significant at the 0.01 level.
** Significant at the 0.05 level.
* Significant at the 0.10 level.

Table 5.4—Relation between preschooler's weight-for-height Z-score and calorie intakes

Explanatory Variables	Estimated Parameters	t-Values
Constant	-6.595	-6.02***
Log child's daily adult equivalent calorie intake	0.245	2.59***
Child's sick days	0.007	0.40
Log household size	-0.166	-0.79
Child's age	0.029	0.91
Square of child's age	-0.0003	-0.95
Sex (dummy)	-0.117	-1.15
Birth order	0.005	0.16
Mother's age	0.026	2.17**
Mother's BMI	0.134	5.08***
Household head's child (dummy)	0.129	0.51
Working mother (dummy)	-0.046	-0.37
Polluted drinking water (dummy)	0.043	0.39
Left without cloth (dummy)	0.073	0.72
Mother's awareness of ORS and immunization (dummy)[a]	0.089	0.76
VGD (dummy)	-1.319	-1.03
Distress area (dummy)	-0.108	-0.99
VGD (dummy) x mother's BMI	0.076	1.06
VGD (dummy) x mother's awareness of ORS and immunization (dummy)	-0.217	-0.72
F-Statistic	3.08***	
$\bar{R}^2$	0.08	

Note: Dependent variable is preschooler's weight-for-height Z-score.

[a] 1 if the mother knows that children should be immunized and should be given oral rehydration saline during diarrhea, 0 if she does not know.

*** Significant at the 0.01 level.
** Significant at the 0.05 level.

Table 5.5—Relation between preschooler's weight-for-age Z-score and calorie intakes

Explanatory Variables	Estimated Parameters	t-Values
Constant	-9.326	-8.44***
Log child's daily adult equivalent calorie intake	0.313	3.28***
Child's sick days	-0.002	-1.38
Log household size	0.158	0.75
Child's age	0.026	0.82
Square of child's age	-0.0003	-0.82
Sex (dummy)	0.059	0.58
Birth order	-0.058	-1.70*
Mother's age	0.038	3.12***
Mother's BMI	0.141	5.31***
Household head's child (dummy)	0.311	1.21
Working mother (dummy)	0.106	0.85
Polluted drinking water (dummy)	0.113	1.01
Left without cloth (dummy)	-0.233	-2.28**
Mother's awareness of ORS and immunization (dummy)	0.154	1.31
VGD (dummy)	-0.309	-0.24
Distress area (dummy)	0.104	0.94
VGD (dummy) x mother's BMI	0.012	0.17
VGD (dummy) x mother's awareness of ORS and immunization (dummy)	-0.049	-0.16
F-Statistic	3.93***	
$\bar{R}^2$	0.11	

Note: Dependent variable is preschooler's weight-for-age Z-score.

*** Significant at the 0.01 level.
** Significant at the 0.05 level.
* Significant at the 0.10 level.

Appendix 6

Table 6.1—Determinants of nutritional status of children aged 0 to 36 months

Explanatory Variables	Estimated Parameters	t-Values
Constant	-2.507	-2.94***
Log daily household income per AEU	-0.11	-0.72
Log child's age	-0.47	-5.33***
Dummy for child's diarrhea[a]	-0.19	-1.30
Child's sick days	-0.003	-1.94**
Dummy for regularly given bath using soap[b]	0.75	2.79***
Left without cloth (dummy)	-0.16	-1.09
Mother's BMI	0.10	2.91***
Ratio of children to total household member	-0.88	-1.37
Household size	-0.04	-0.85
Pulses given as weaning food (dummy)[c]	0.001	
Vegetables given as weaning food (dummy)[d]	0.32	2.15**
Weaning starting age of child	0.01	0.48
Birth order	-0.06	-1.93**
Sex (dummy)	0.14	1.06
Dummy for breast fed child[e]	-0.26	-1.57
F-Statistic	5.23***	
$\bar{R}^2$	0.14	

Note: Dependent variable is weight-for-age Z-score of children aged 0 to 36 months.

[a] 1 if the child suffered from diarrhea in the last two weeks.
[b] 1 if the child is regularly given bath using soap.
[c] 1 if pulses given as weaning food.
[d] 1 if vegetables given as weaning food.
[e] 1 if the child is breast fed.

*** Significant at the 0.01 level.
** Significant at the 0.05 level.

Appendix 7

Consumption Effects of Income Sources

Table 7.1—Influences of different sources of income on total food consumption of VGD beneficiary households

	Estimated Parameters	
Explanatory Variables	Model	Hypothesis
Constant	7.744 (3.25)***	6.622 (2.66)***
Own cash income	0.589 (23.24)***	.....
Borrowed cash income	0.617 (16.37)***	.....
VGD income transfer	0.922 (5.86)***	.....
Other in-kind income	0.81 (14.08)***	.....
Rice price relative to wheat price	-5.457 (-3.00)***	-3.654 -(2.07)**
Household size	0.072 (0.98)	-0.058 (-1.26)
Number of guests	-0.166 (-0.67)	-0.227 (-0.87)
Total income	.....	0.628 (25.07)***
F-Statistic	131.24***	199.31***
$\bar{R}^2$	0.89	0.87

Notes: Dependent variable is daily household food expenditure per AEU.

Figures in the parentheses show the t-values.

*** Significant at the 0.01 level.
** Significant at the 0.05 level.

Table 7.2—Tests for differences in marginal propensities to spend on food out of income transfer and all other cash and in-kind income

Under the model:	
Marginal propensity to spend on food	
Own cash income	0.59
Borrowed cash income	0.62
Subsidy income	0.92
Other income in-kind	0.62
RSS	103.14
Number of households (N)	117
Under the hypothesis (H_o):	
Marginal propensity to spend on food	
Total income	0.63
RSS	119.77
Number of households (N)	117
Test	
F*	5.698
$F_2^{0.05}$, N-7	3.07
Result of test	Reject H_o
Test of differences between MPCs under the model*:	
	Chi-square value
Own cash income vs. borrowed cash income	0.90
Own cash income vs. income transfer in wheat	4.28**

Note: RSS = Residual sum of squares.

* The Wald test is used to test the hypotheses.

** Significant at the 0.05 level.

Table 7.3—Influences of different sources of income on household consumption of calorie and protein[a]

Explanatory variables	Estimated Parameters			
	Model		Hypothesis	
	Calorie	Protein	Calorie	Protein
Constant	175.435 (0.51)	-0.045 (-0.02)	922.094 (4.50)***	28.152 (5.09)***
Cash income	110.369 (11.66)***	2.294 (9.44)***	-	-
Income transfer in wheat	400.866 (4.30)***	13.451 (5.63)***	-	-
Income transfer in rice	194.229 (2.07)**	5.208 (2.17)**	-	-
Other income in kind	240.158 (5.62)***	4.768 (4.35)***	-	-
Household size	33.415 (1.16)	1.149 (1.56)	-21.616 (-0.95)	-0.912 (-1.49)
Ratio of baby to total household member	-1068.352 (-1.08)	-40.525 (-1.59)	-839.183 (-0.79)	-32.648 (-1.15)
Ratio of children to total household member	454.017 (1.11)	9.112 (0.87)	246.329 (0.59)	-0.957 (-0.09)
Ratio of youth to total household member	137.946 (0.48)	1.173 (0.16)	-50.346 (-0.18)	-7.34 (-0.95)
Total income	-	-	115.726 (11.83)***	2.412 (9.14)***
F-Statistic	28.34***	24.12***	35.69***	24.78***
$\bar{R}^2$	0.64	0.60	0.59	0.49

[a] Expenditure data from the second round survey was used for these regressions. Only VGD beneficiary households were included.

Figures in the parentheses show the t-values.

*** Significant at the 0.01 level.
** Significant at the 0.05 level.
* Significant at the 0.10 level.

Table 7.4—Tests for differences in marginal propensities to consume calorie and protein out of income transfers in rice and wheat and all other cash and in-kind income

Under the model:	Calorie (kcal/day)	Protein (gm/day)
Marginal propensity to consume		
Cash income	110.37	2.29
Income transfer in rice	194.23	5.21
Income transfer in wheat	400.87	13.45
Other income in-kind	240.16	4.77
RSS	27646826	18194
Number of households (N)	123	123
Under the hypothesis (H_o):		
Marginal propensity to consume		
Total income	115.73	2.41
RSS	32723474	23794
Number of households (N)	123	123
Test		
F*	6.98	11.70
$F_3^{0.05}$,N-9	2.68	2.68
Result of test	Reject H_o	Reject H_o
Test of differences between MPCs under the model[1]:	Chi-square values	
Cash income vs Income transfer in rice	0.84	1.55
Cash income vs Income transfer in wheat	9.99***	22.39***
Income transfer in wheat vs Income transfer in rice	9.12***	22.06***

Note: Dependent variables are daily per capita calorie consumption per household for the first equation and daily per capita calorie consumption per household for the second equation.

[1] The wald test was used to test the hypotheses.

*** Significant at the 0.01 level.

Appendix 8

Consumption Effects of Income Transfer

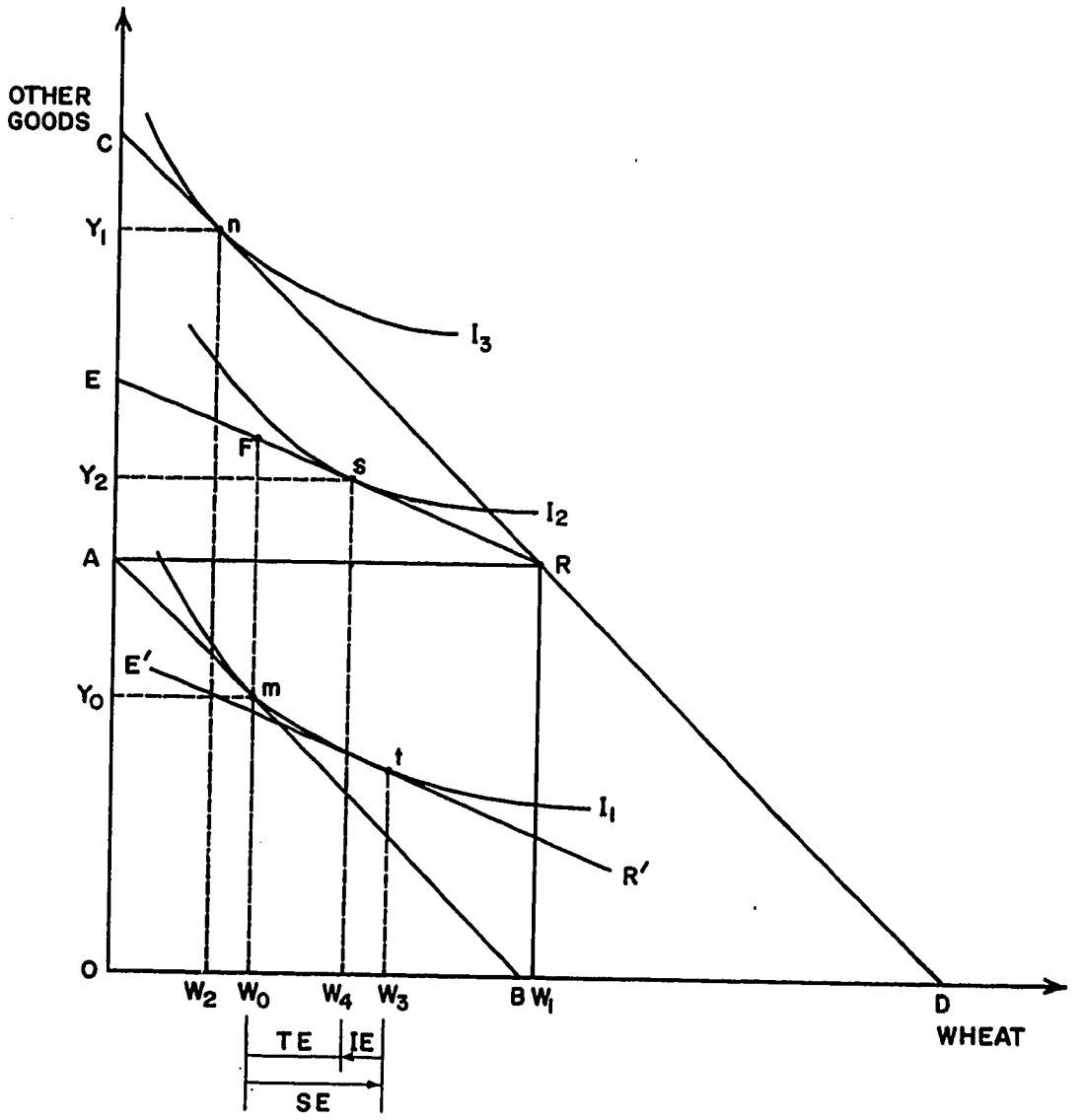
The effects of a subsidized rationed food on household consumption of goods (food and non-food items) will depend on the relative size of the ration, and its resale status. If the size of the ration is less than what a household would have consumed without the ration, then the ration is inframarginal. The ration is extramarginal if the ration quantity is greater than the amount of that commodity the household would have consumed without the ration.

If the ration is extramarginal, and if the resale of ration is prohibited or entails a high transaction cost, then the income transfer through such a ration may have two effects--an income effect and a substitution effect. On the other hand, the effect of an inframarginal ration is equivalent to the income effect only (that is, the value of the income transfer from ration), regardless of its resale status.

Extramarginal Ration

The likely household-level consumption effects of an extramarginal ration are illustrated in Figure 8.1, using the example of the VGD wheat ration. The quantity of wheat (W) is shown on the horizontal axis, and the aggregate quantity of all other goods (Y) is shown on the vertical axis. Each indifference curve (I_1, I_2, and I_3) identifies the various combinations of W and Y that would give the household equal satisfaction. The budget line AB represents the maximum quantities of W and Y that the household could purchase with its given budget

Figure 8.1—Consumption effects of extramarginal ration



before participating in the program. The optimum choice of the household before entering the program is denoted by the point m where the household selects the combination of OW_o amount of wheat and OY_o amount of all other goods for consumption. This is the point at which the budget line AB just touches the indifference curve I_1, that is, the point of tangency m.

The VGD program provides a fixed monthly free ration of 31.25 kilograms of wheat per participating household. If the resale of rationed wheat is absolutely prohibited, then the recipient household would consume the entire amount of the ration, denoted by OW_1. This would lead to two types of movement in the budget line: it would rotate around the vertical intercept A and would become a horizontal line upto the point R, corresponding to the OW_1 quantity of rationed wheat. This portion of the budget line would be horizontal because the price of the OW_1 quantity of rationed wheat is zero. The point R represents an endowment bundle that allows the recipient household to consume OW_1 quantity of wheat and OA quantity of all other goods. Beyond point R, the movement represents an outward shift parallel to the original budget line from AB to RD. The new budget line is depicted by ARD, with a kink at point R.

The resale of VGD wheat is, however, not prohibited. If the recipient household could sell the entire ration at market price, then the budget line would shift outward in a parallel way, passing through the endowment bundle R. Here, the effect of income transfer in wheat is equivalent to the income effect only. From the IFPRI household survey data, the income elasticity of demand for wheat for the rural households has been estimated at -0.2. The negative income

elasticity implies that wheat is an inferior good in rural areas, that is, a ten percent increase in income would lead the households to consume two percent less of wheat. Thus, the household consumption bundle would be, say, at point n where the budget line CD just touches the highest indifference curve I_3. The household would consume OW_2 amount of wheat and OY_1 amount of all other goods. Since wheat is probably an inferior good, the household would consume less wheat than the amount it would have consumed without the ration, OW_o. Thus, the income transfer would lead to a reduction in household wheat consumption in this case.

If the resale price of rationed wheat is lower than the market price, or if the resale entails a high transaction cost that decreases the implicit selling price, then the upward portion of the budget line from the endowment bundle (point R) would become flatter. Since the endowment bundle is always affordable, the budget line would rotate around the point R. However, the RD portion of the budget line is unaffected as the market price of wheat remains unchanged. The resultant budget line is represented by ERD with a kink at point R, as depicted in Figure 8.1.

The IFPRI survey data suggests that, on the average, the VGD recipient households sold about 19 percent of their wheat ration at a price lower than the market price. However, the remaining quantity consumed was more than double the quantity consumed by the control group of households. Since wheat is an inferior good, the resale of a portion of wheat ration at a lower price, yet the larger quantity consumed indicate that the household consumption bundle is located on

the FR portion of the budget line. The optimum choice of the household is denoted by the consumption bundle at point s. The household indifference curve I_2 is tangent to the budget line at this point. The household would consume OW_4 amount of wheat and OY_2 amount of all other goods.

To show the income and the substitution effects of OW_4 amount of wheat consumption, the line E'R' is drawn parallel to line ER which just touches the original indifference curve I_1 at point t. The movement along indifference curve I_1 from m to t is attributable to the substitution effect (SE) of lowering the price of rationed wheat. The substitution effect of a price change is always negative, that is, a fall in price of a commodity must always increase the consumption of that commodity. However, since wheat is an inferior good (as the estimates suggest), the income effect (IE) would offset part of the substitution effect. The total effect (TE) would still be an increase in wheat consumption (OW_4-OW_o), because wheat is not a "Giffen good". The household would increase its consumption of all other goods by the amount (OY_2-OY_o) due to the income and the cross-price effects of the ration.

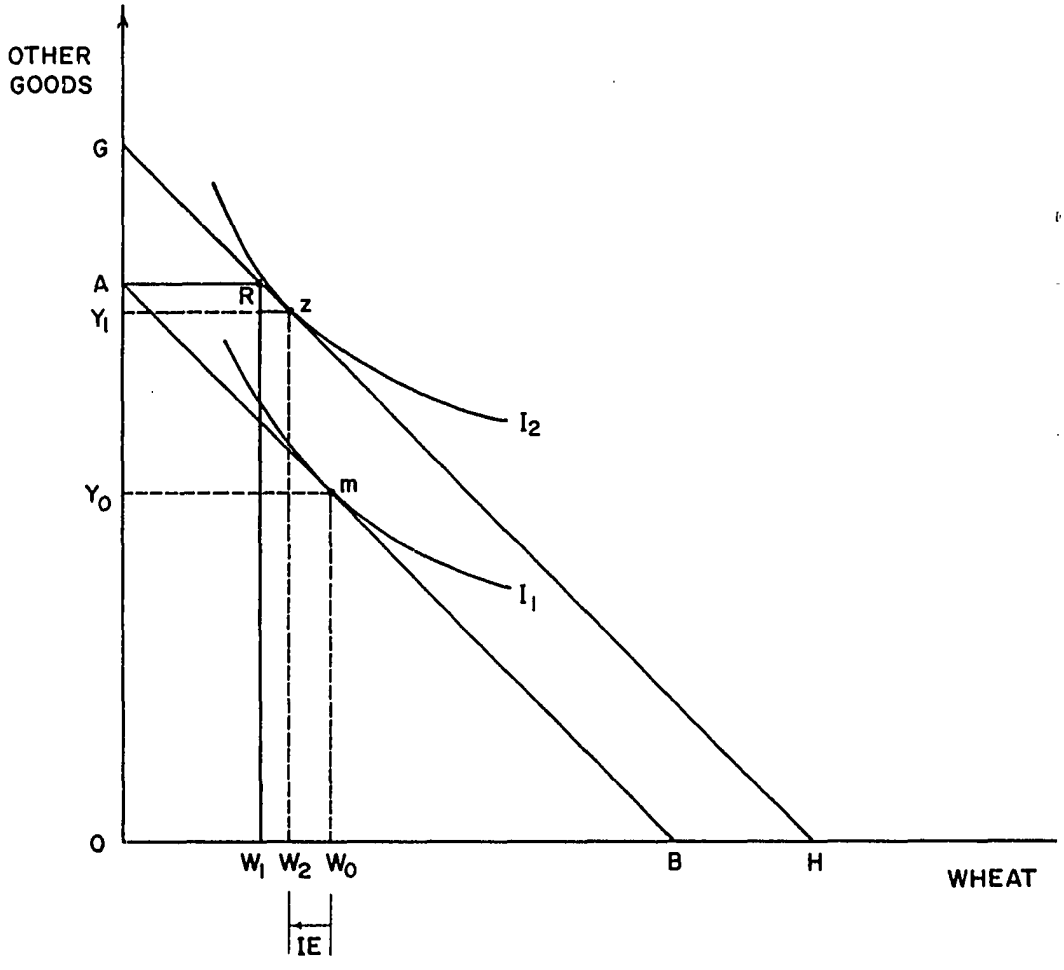
A digression: If the household can sell the entire ration at market price, then the consumption effect would be exactly the same as that of the equivalent value of cash transfer. As microeconomic theory suggests, a household will be better-off if it can reach a higher indifference curve. Figure 8.1 indicates that a cash transfer would enable the household to reach the highest feasible indifference curve I_3, where the household maximizes its satisfaction by selecting the consumption bundle at point n. This explains why should cash transfer yield

higher satisfaction than in-kind transfer, in terms of recipient's own perception of welfare (see Box 1 for discussion).

Inframarginal Ration

Figure 8.2 depicts the consumption effects of an inframarginal wheat ration. The rationed quantity OW_1 is less than the OW_0 quantity consumed by the household before participating in the program. This leads the budget line to shift outward in a parallel way from the original budget line AB, which indicates that the inframarginal ration has only the income effect. The new budget line is denoted by GH. Again, assuming the income elasticity of demand for wheat is negative, the subsequent consumption bundle would be, say, at point z where the budget line GH is tangent to the indifference curve I_2. The household would consume OW_2 amount of wheat, and OY_1 amount of other goods. This indicates that the household would reduce its wheat consumption with an increase in income from the income transfer, because wheat is an inferior good. The potential substitution effect on wheat consumption from the subsidized ration will be lost entirely because the size of the ration is less than the pre-subsidy quantity consumed.

Figure 8.2—Consumption effects of inframarginal ration



Appendix 9

Regression Results Used in the Simulation Exercise

Table 9.1—Determinants of daily household adult equivalent calorie intakes

Explanatory Variables	Estimated Parameters	t-Values
Constant	194.112	0.44
Income per AEU without subsidy	66.368	14.21***
RR income transfer per AEU	89.275	0.85
VGD income transfer per AEU	206.984	5.95***
Rice price over wheat price	908.198	2.58***
Household size	14.142	1.18
Number of guests	-141.429	-2.27***
Distress area (dummy)	-99.731	-1.59
F-Statistic 31.26***		
$\bar{R}^2$ 0.33		

Note: Dependent variable is daily Household calorie intake per AEU.

*** Significant at the 0.01 level.

Table 9.2—Determinants of mother's daily adult equivalent calorie intakes

Explanatory Variables	Estimated Parameters	t-Values
Constant	684.881	3.91***
Daily household calorie intake per AEU	0.790	13.49***
Mother's sick days	-2.261	-2.88***
Mother's age	-10.738	-2.68***
Mother's education	5.760	0.59
Working mother (dummy)	-225.395	-3.56***
Dummy for widow[a]	69.007	0.42
Household head mother (dummy)[b]	46.270	0.26
F-statistic	32.29***	
$\bar{R}^2$	0.41	

Note: Dependent variable is mother's daily adult equivalent calorie intake.

[a] 1 if the mother is a widow.
[b] 1 if mother is household head.

*** Significant at the 0.01 level.

Table 9.3—Determinants of mother's body mass index (BMI)

Explanatory Variables	Estimated Parameters	t-Values
Constant	17.222	24.17***
Mother's adult equivalent calorie intake per day	0.0005	2.74***
Mother's sick days	-0.004	-1.33
Mother's age	0.007	0.29
Number of pregnancies	-0.143	-2.36***
Dummy for widow	-0.508	-0.84
Per capita space available in the household	0.047	0.93
F-statistic 4.42***		
$\bar{R}^2$ 0.06		

Note: Dependent variable is mother's BMI.

*** Significant at the 0.01 level.

Table 9.4—Determinants of child's daily adult equivalent calorie intakes

Explanatory Variables	Estimated Parameters	t-Values
Constant	-1649.686	-3.86***
Daily household calorie intake per AEU	0.535	8.89***
Household size	-8.224	-0.42
Child's age in month	74.241	4.24***
Square of child's age in month	-0.661	-3.28***
Number of child's sick days	0.490	0.48
Sex (dummy)	-37.094	-0.65
Birth order	2.404	0.19
Household head's child (dummy)	314.807	2.37***
Working mother (dummy)	91.703	1.34
Education of child's mother	-12.638	-1.11
Number of guests	-145.776	-1.78*
F-statistic	14.18***	
$\bar{R}^2$	0.29	

Note: Dependent variable is child's (aged below five years) daily adult equivalent calorie intake.

*** Significant at the 0.01 level.
* Significant at the 0.10 level.

Table 9.5—Determinants of preschooler's nutritional status

Explanatory Variables	Estimated Parameters	t-Values
Constant	-5.642	-5.70***
Adult equivalent calorie intake of child per day	0.0002	2.40***
Number of child's sick days	0.002	1.05
Child's age in month	0.020	0.59
Square of child's age in month	-0.0002	-0.62
Sex (dummy)	-0.064	-0.59
Birth order	0.005	0.14
Age of the child's mother	0.017	1.32
BMI of the child's mother	0.170	5.99***
Polluted drinking water (dummy)	0.012	0.09
Mother's awareness of ORS and immunization (dummy)	0.034	0.29
Ratio of children to total member	-0.141	-0.23
Household head's child (dummy)	0.125	0.52
F-Statistic	4.05***	
$\bar{R}^2$	0.09	

Note: Dependent variable is preschooler's weight-for-height Z-score.

*** Significant at the 0.01 level.

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