# Elements of a National Food-Fortification Program for Bangladesh

MOST
The USAID Micronutrient Program

USAID
UNITED STATES AGENCY FOR INTERNATIONAL DEVELOPMENT

This publication was made possible through support provided by the Office of Health, Infectious Disease and Nutrition, of the Bureau for Global Health, U.S. Agency for International Development (USAID).

MOST is managed by the International Science and Technology Institute, Inc. (ISTI) under the terms of Cooperative Agreement No. HRN-A-00-98-0047-00. Partners are the Academy for Educational Development (AED), Helen Keller International (HKI), the International Food Policy Research Institute (IFPRI), and Johns Hopkins University (JHU). Resource institutions are CARE, the International Executive Service Corps (IESC), Population Services International (PSI), Program for Appropriate Technology in Health (PATH), and Save the Children.



Suggested Citation:

MOST, USAID Micronutrient Program. 2004. *Elements of a National Food-Fortification Program for Bangladesh*. Arlington, Virginia, USA

# Elements of a National Food-Fortification Program for Bangladesh

J u n e  2 0 0 4

Omar Dary
Bechir Rassas

This study builds on a recent pilot wheat-flour fortification program in Bangladesh. Performed through MOST for USAID/Dhaka, the pilot program was a limited-term project to improve vitamin A and iron status and also to reduce anemia through consumption of fortified wheat flour with vitamin A, iron, zinc, B1, B2, niacin, and folic acid. The study's primary objective is to identify major elements of a food-fortification strategy in Bangladesh, including micronutrient formulation for the food vehicles identified as suitable for fortification.

# Table of Contents

## List of Tables

# Acronyms

| | |
|---|---|
| BSFIC | Bangladesh Sugar and Food Industries Corporation |
| EAR | Estimated average requirement |
| FAO | Food and Agriculture Organization of the United Nations |
| GOB | Government of Bangladesh |
| MOST | The USAID Micronutrient Program |
| MT | Metric ton |
| NFA | National Fortification Alliance |
| NGO | Non-Government Organization |
| NPAN | National Plan of Action for Nutrition |
| QC | Quality control |
| VGD | Vulnerable Group Development |
| USAID | United States Agency for International Development |
| WFP | World Food Programme |

Currency Unit: TK58 = $1

# Summary


## Background, Objective, and Methodology

This study was prepared under MOST, the USAID Micronutrient Program. Funded by the Office of Health and Nutrition of the United States Agency for International Development (USAID), MOST is USAID's flagship project for the promotion of activities to improve the micronutrient status of at-risk populations throughout the world.

The study, which was conducted in April-May 2004, builds on a recent pilot wheat-flour fortification program in Bangladesh. Performed through MOST for USAID/Dhaka, the pilot program was a limited-term project to improve vitamin A and iron status and also to reduce anemia through consumption of fortified wheat flour with vitamin A, iron, zinc, B1, B2, niacin, and folic acid.

This study's primary objective is to identify major elements of a food-fortification strategy in Bangladesh, including micronutrient formulation for the food vehicles identified as suitable for fortification.

Data were collected from available documents with relevance to the oil, wheat, and sugar industries, and from extensive interviews with officials of the Government of Bangladesh (GOB) and other key personnel in Dhaka during a two-week visit to Bangladesh.

## Current Efforts to Reduce Micronutrient Deficiency in Bangladesh

Bangladesh has achieved considerable progress in reducing poverty, child mortality, and malnutrition. Despite these improvements, however, poverty remains alarmingly high, and the overall level of child malnutrition remains one of the highest in the world. Only 32 percent of the population meet calorie requirements, 46 percent meet protein requirements, and 25 percent meet fat requirements. Intake is low for most micronutrients, vitamin A indicators for children and women indicate the presence of a serious public health problem, and anemia is widespread among all population groups.

Bangladesh regards improved nutrition as a top government priority. Ongoing programs to reduce micronutrient deficiency include dietary diversification and other food-based interventions such as development of home gardens, poultry, fisheries, and other small farm animals at the community level; salt iodization; and universal vitamin A supplementation for young children and lactating women.

Food fortification was initiated with the implementation of a pilot wheat-flour fortification activity. Building on that initiative, the GOB has launched an effort to examine the suitability of other food-fortification vehicles. As a result of these interventions, it is expected that food-fortification will soon become an important element of the country's strategy to reduce micronutrient malnutrition.

## Elements of a National Food-Fortification Program

### Food Vehicles and Fortification Regime

This study considered three food-fortification vehicles: oil, wheat flour, and sugar. The suitability of each is briefly summarized below.

#### *Oil*

Oil is a most suitable food-fortification vehicle in Bangladesh. Mustard-seed oil, soybean oil, and palm oil are the country's three major sources of edible oil. Since mustard-seed oil is not suitable for fortification, however, the fortification program should concentrate on soybean and palm oils. Right now, per capita consumption of both these oils is adequate and rapidly increasing. For example, per capita consumption increased from 10g/day in 1999-2000, to 14g/day on average between 2000-2001 and 2002-2003, and was as high as 17g/day in 2000-2002. Fortified at a minimum vitamin A level of 20mg/kg, consumption of 13g/day/person of oil would supply more than 50 percent of the estimated average requirement (EAR).

At Tk 223, or $3.85 per metric ton (MT), oil has the lowest fortification cost among the three commodities considered — about 20 percent below wheat-flour fortification cost and well below sugar-fortification cost. In addition, total fortification costs, including vitamin A, are estimated at 0.46 percent of retail price for oil (0.43 percent for soybean oil and 0.53 percent for palm oil) — suggesting that oil fortification will not have any meaningful impact on consumption.

These cost estimates do not include the 47 percent import duty currently imposed on micronutrients. Taking the import tax into consideration raises the costs of oil fortification to $5.62/MT, with a corresponding increase in retail prices. The same conclusion applies to wheat flour and oil, suggesting that elimination of the import duty on micronutrients should be considered.

Soybean oil and palm oil are imported in an unrefined form. These imports are then processed by a limited number of producers. Of the 15 active oil producers in Bangladesh, 3 have an individual capacity of over 1,000 MT/day and process 80-90 percent of all soybean and palm oil imports. Both the size and limited number of producers suggest that mandatory fortification for oil would be the most-effective strategy.

#### *Wheat Flour*

Wheat flour is a suitable food-fortification vehicle in Bangladesh. The structure of the milling industry suggests that the wheat-flour fortification program should rely on roller mills rather than on chakki mills (small stone mills). It should also be private-sector driven and voluntary.

Per capita wheat-flour consumption is estimated at 43g/day. Fortification of wheat flour would supply about 20 percent of EAR for vitamin A, iron, folate, B-12, B-1, B-2, B-6, niacin, and zinc.

Fortification costs for wheat flour are about Tk295, or $5 per MT, and represent about 1.6 percent of retail prices, suggesting that the additional cost of fortification does not appear prohibitive to consumers.

#### *Sugar*

Strong evidence presented in this study suggests that sugar fortification in Bangladesh is not recommended. Because the bulk of sugar consumed is imported in an already refined form, it places severe limitations on the amount of sugar available for fortification. Local production is only about 20-25 percent of total sugar consumption, equivalent to less than 2g/day/person. Per capita sugar consumption in rural areas, where most of the vulnerable groups can be found, is even lower.

At about Tk630, or $10.8 per MT, the cost of sugar fortification is over twice as high as that for wheat flour and nearly three times that for oil. The additional cost associated with fortification would increase the retail price of sugar by over 2 percent. Assuming fortification costs are passed on to consumers, this increase may place fortified sugar at a disadvantage relative to the imported unfortified product.

### Fortification Formulation

The table below describes the fortification formulation and micronutrient supply for oil and wheat flour in Bangladesh. Fortified at a minimum vitamin A level of 20mg/kg, oil would supply about 52 percent of EAR — an amount expected to have a significant biological impact. Based on the formulation described in the table, fortification of *maida* (refined flour) would supply about 20 percent of EAR for vitamin A, iron, folate, B-12, B-1, B-2, B-6, niacin, and zinc.

## National Capacity to Implement Food Fortification

There is fervent commitment to food fortification in Bangladesh at the highest level of government, and a strong public and private-sector partnership is emerging. In December 2003, the Bangladesh Food Fortification Alliance (NFA) was formed, consisting of more than 30 members from the public and private sectors, civil society, and international development partners. A Technical Committee was also selected to provide specialized support to NFA and its members. NFA's first meeting took place in April 2004.

A rapid assessment conducted for this study indicates that Bangladesh has the necessary human and institutional capacity to implement food fortification on a national scale. However, available evidence suggests that while NFA partners are interested in food fortification, they will be unable to put the program into action without some technical support. An integrated package of key technical assistance interventions provided by USAID, the Global Alliance for Improved Nutrition, and other donors would create the conditions for NFA partners to proceed.

**Fortification Formulation and Micronutrient Supply for Wheat Flour (*Maida*) and Oil in Bangladesh**

| Nutrient | Form | Minimum Level of Addition (mg/kg) * | Overage (%) ** | % EAR in Usual Consumption *** |
|---|---|---|---|---|
| | | **Wheat Flour** | | |
| Vitamin A | SD250 | 2 | 50 | 16 |
| Iron | Ferrous fumerate | 45 | 5 | 20 |
| Folate | Folic acid | 2 | 50 | 23 |
| B-12 | B-12 — 0.01% | 0.010 | 30 | 18 |
| B-1 | Thiamin mononitrate | 6 | 40 | 18 |
| B-2 | Riboflavin | 4 | 30 | 16 |
| B-6 | Pyridoxin | 5 | 20 | 19 |
| Niacin | Niacinamide | 40 | 10 | 16 |
| Zinc | Zinc oxide | 20 | 5 | 19 |
| | | **Oil** | | |
| Vitamin A | Vitamin A oily 1.7mIU/g | 20 | 5 | 52 |

**Notes:**

* Selected (1) to provide at least 20 percent EAR from 50g/day/person of wheat flour consumption, (2) to be compatible with the sensorial properties of the product, and (3) to be safe for those who consume large amounts of the product.

** The additional amount over the minimum level to compensate for losses in production, storage, and transportation.

*** 40g/day for wheat flour and 13g/day for oil; values for families, adult male.

# Section 1: Introduction

## Background

This study was prepared under MOST, the USAID Micronutrient Program. Funded by the Office of Health and Nutrition of the United States Agency for International Development (USAID), MOST is USAID's flagship project for the promotion of activities to improve the micronutrient status of at-risk populations throughout the world.

The study builds on a recent pilot wheat-flour fortification program in Bangladesh. Performed through MOST for USAID/Dhaka, the pilot program was a limited-term project to improve vitamin A and iron status and also to reduce anemia through consumption of fortified wheat flour with vitamin A, iron, zinc, B1, B2, niacin, and folic acid.

Vitamin A and iron deficiency has led to high rates of night blindness, anemia, reduced immune response, and other health problems in Bangladesh, particularly among children and pregnant women. In 1995, the Government of Bangladesh (GOB) implemented a universal vitamin A capsule distribution program that achieved high coverage for children 6 months to 5 years of age. Although the program has lowered the incidence of night blindness and other health problems associated with vitamin A deficiency, significant constraints remain. In particular, women are not covered, and many other important micronutrients are not being supplied through capsule distribution.

The GOB initiated the pilot trial wheat-flour fortification program in August 1999, in collaboration with USAID/Dhaka. The purpose of the program was to examine the feasibility of reducing micronutrient deficiency through food-fortification and to verify the applicability of known fortification technologies to the local situation. Program activities were designed to generate important information on the feasibility of wheat-flour fortification on a larger scale. To achieve this objective, several activities were undertaken:

- An organoleptic study to evaluate the organoleptic qualities of the fortified wheat flour and its products
- An efficacy study to assess the health impact of the fortified wheat flour on the iron and vitamin A status of the recipient population
- A utilization and acceptability study to ascertain beneficiaries' use of the wheat flour
- A cost analysis and sustainability study to assess cost factors and sustainability requirements for a nationwide program
- A promotional and educational campaign to inform recipients of the health benefits of the fortified wheat flour

The wheat-flour fortification program demonstrated that wheat-flour fortification on a national scale would be both feasible and desirable. Following the success of the wheat-flour fortification experience, the GOB requested USAID/Dhaka assistance to examine the feasibility of fortifying other food vehicles such as edible oil and sugar. This study took place in response to that request.

## Objective

The primary objective of this study is to identify major elements of a food-fortification strategy in Bangladesh, including micronutrient formulation for the food vehicles identified as suitable for fortification, equipment needed, and packaging and labeling requirements.

## Methodology

This study, conducted in April-May 2004, collected data from available documents with relevance to the oil, wheat, and sugar industries, and from extensive interviews with GOB officials and other key personnel in Dhaka during a two-week visit to Bangladesh. Two visits were made to oil, wheat flour, and sugar mills in the Dhaka area and Natore. Major findings and conclusions were presented to USAID, GOB officials, and members of the technical committee of the newly created National Fortification Alliance (NFA).

The study is divided into five sections. Following this introductory material, section 2 describes the nature of the micronutrient problem in Bangladesh. Section 3 examines three potential food-fortification vehicles: edible oil, wheat flour, and sugar, with cost analysis of fortification for the three commodities presented in section 4. Major elements of a national food-fortification program are identified in the final section, which examines food vehicles and fortification formulation, production, and packaging and labeling requirements.

# Section 2: Nature of the Micronutrient Problem

## Malnutrition

Bangladesh has achieved considerable progress in reducing poverty, child mortality, and malnutrition. Despite these improvements, however, poverty remains alarmingly high. Nearly 45 percent of the population remained below the poverty line in 2000, and 20 percent lived in hardcore poverty — defined as consuming fewer than 1,800 calories per day. In urban areas, those percentages are 52 percent and 25 percent, respectively (Bangladesh Bureau of Statistics 2001).

Children in Bangladesh suffer from short-term acute food deficits (as reflected in low weight-for-age) as well as from longer-term chronic under-nutrition (as reflected in high rates of stunting). As shown in table 2.1, the rate of stunting for children below six years of age was about 49 percent in 2000 (38 percent in urban areas and 50 percent in rural areas). Within the same age group, the proportion of underweight children was about 50 percent (42 percent in urban areas and 53 percent in rural areas), and wasting was over 10 percent. Between 13 percent and 19 percent of children were severely underweight or stunted.

**Table 2.1. Trends in Various Indicators of Malnutrition in Bangladesh**

| Nutrition Status Indicator | Child Nutrition Survey, 2000 | | | Demographic & Health Survey 1999-2000 |
|---|---|---|---|---|
| | Urban | Rural | All | |
| Stunting (height-for-age) % below 2 standard deviations | 38.3 | 50.7 | 48.8 | 45 |
| Underweight (weight-for-age) % below 2 standard deviations | 42.2 | 53.8 | 51.1 | 48 |
| Wasting (weight-for-height) % below 2 standard deviations | 11.8 | 11.9 | 11.7 | 10 |

Source: World Bank 2002a.

The overall level of child malnutrition in Bangladesh remains one of the highest in the world. In the late 1990s, Bangladesh ranked second in terms of the proportion of underweight children below five years of age and fourth in terms of the proportion of children stunted. Bangladesh also had the second-highest percentage (30 percent) of infants with low birth weight in the world (Ministry of Finance 2002b).

Malnutrition in Bangladesh varies by geographic location, with children in rural areas having higher incidence of malnutrition than in urban areas. The lowest rates of child malnutrition are found in the urban areas of Dhaka and Khulna division. There are large differences in child malnutrition across economic groups, with the poor having the highest incidence of malnutrition.

As shown in table 2.2, only 32 percent of the population meet calorie requirements, 36 percent meet protein requirements, and 25 percent meet fat requirements. In rural areas, these proportions are higher for calories (35 percent) but lower for protein (45 percent) and fat (21 percent) — reflecting the importance of cereals in their diet, especially rice.

## Micronutrient Deficiency

Table 2.3 describes nutrition adequacy in terms of estimated average requirement (EAR). Micronutrient intake is low for calcium, iron, vitamin A, and vitamin B-2. Although not evaluated in the table, intakes of vitamin B-12 and zinc are likely to be low because their sources are similar to those for the other micronutrients listed. Table 2.3 shows that intake is adequate (higher than 100 percent of EAR) only for vitamin B-1 and niacin.

Table 2.4 shows vitamin A indicators for children and women. In all cases, serum retinol levels indicate the presence of a serious public health problem (percent deficiency higher than 15 percent). Deficiency figures are lower among preschoolers due to the vitamin A supplementation program. However, while supplementation has reduced clinical and ocular signs of vitamin A deficiency in this age group, their serum retinol level remains low.

**Table 2.2. Percent of Population Able to Meet Calorie, Protein, and Fat Requirements in Bangladesh (1995-96)**

| Intake as a % of Requirement | Calories | | | Protein | | | Fat | | |
|---|---|---|---|---|---|---|---|---|---|
| | Rural | Urban | All | Rural | Urban | All | Rural | Urban | All |
| < 80% | 36 | 50 | 39 | 32 | 31 | 32 | 70 | 49 | 65 |
| 80-90% | 15 | 16 | 15 | 11 | 10 | 11 | 5 | 6 | 5 |
| 90-99% | 14 | 12 | 14 | 11 | 10 | 11 | 4 | 5 | 4 |
| 100% & above | 35 | 22 | 32 | 45 | 49 | 36 | 21 | 40 | 25 |

Source: Jahan and Hussain 1998

**Table 2.3. Micronutrient Adequacy in Bangladesh (1995-96)**

| Nutrient | EAR (mg/day) | Intake (mg/day) | | % EAR | |
|---|---|---|---|---|---|
| | | Rural | Urban | Rural | Urban |
| Calcium | 833 | 328 | 363 | 40 | 43 |
| Iron | 21.6 | 11 | 13 | 51 | 60 |
| Vitamin A * | 429 | 259 | 378 | 43 | 88 |
| B-1 | 1 | 1.2 | 1.1 | 120 | 110 |
| B-2 | 1.1 | 0.5 | 0.5 | 41 | 41 |
| Niacin | 12 | 19 | 17 | 160 | 141 |

**Note:**

* Based on new equivalence factor of 1:12 for B-carotene, instead of 1:6 (retinol: B-carotene).

Source Calculations using data in Jahan and Hossein 1998

**Table 2.4. Vitamin A Deficiency in Bangladesh (percent below the reference point)**

| Age Group & Gender | Reference Point (mmol/l) | % Deficiency |
|---|---|---|
| 1-5 years old | < 0.7 | 22 |
| School Children | < 1.05 | 74 |
| Adolescent Girls | < 1.05 | 47 |
| Women | | |
| Non-pregnant | < 1.05 | 30 |
| Pregnant | < 1.05 | 47 |
| Lactating | < 1.05 | 46 |

Source: Mannan 2002

**Table 2.5. Anemia Prevalence in Bangladesh (percent)**

| Age Group & Gender | Year | | |
|---|---|---|---|
| | 1999 | 1995-96 | |
| | | Rural | Urban |
| Preschoolers | 52 | | |
| Male | — | 60.4 | 29.3 |
| Female | — | 79.4 | 47.1 |
| 5-14 years | | | |
| Male | — | 78 | 65 |
| Female | — | 83 | 76 |
| Women | | | |
| Non-pregnant | 38.9 | 85.2 | 69.2 |
| Pregnant * | 49.2 | 60 | 53.4 |
| Lactating | 48.7 | 83.7 | 80.9 |

**Note:**

* Anemia is normally higher for pregnant women. The reference criteria used to assess anemia might explain the unusual results presented here.

Source: Johan and Hussein 1998; Helen Keller 2001.

Table 2.5 demonstrates that anemia is a very serious health problem for all age and population groups. Anemia is substantially higher in rural areas than in urban areas for both men and women and for all age groups. It is also significantly higher for women than for men for all geographic locations and age groups.

## Current Efforts to Reduce Micronutrient Deficiency

As reflected in its National Plan of Action for Nutrition (NPAN), prepared in collaboration with government professionals, non-governmental organizations (NGOs), private-sector agencies, and donor organizations in 1997, Bangladesh regards improved nutrition as a top government priority. The NPAN is tasked with analyzing the current nutrition situation in Bangladesh, defining objectives and targets, formulating a strategic framework for plan implementation, and defining the institutional framework for translating those plans into action.

NPAN has five central components:

- Promote breastfeeding and complementary feeding
- Care for the economically deprived and nutritionally vulnerable
- Promote appropriate diets and healthy lifestyles
- Enhance nutrition education, advocacy, and community participation
- Reduce micronutrient deficiency

Ongoing programs to reduce micronutrient deficiency in Bangladesh are dietary diversification and other food-based interventions, including development of home gardens, poultry, fisheries, and other small farm animals at the community level; salt iodization; and universal vitamin A supplementation for young children and lactating women.

## Food Fortification and Micronutrient Malnutrition

Despite the success of vitamin A supplementation and related activities, especially for preschoolers, significant efforts are still needed to reduce micronutrient malnutrition. As part of its strategy to further reduce this deficiency, the GOB requested USAID assistance to introduce food fortification.

Food fortification — the addition of micronutrients to processed foods — is a food-based approach for the prevention of micronutrient malnutrition. Fortification of widely consumed foods can result in rapid improvements in the micronutrient status of large segments of the population. Other advantages of food fortification are that it does not require changes in consumption patterns and relies upon an existing delivery infrastructure.

The food-fortification program in Bangladesh was initiated with the implementation of a pilot wheat-flour fortification activity. Building on that initiative, the GOB has launched an effort to examine the suitability of other food-fortification vehicles. As a result of these interventions, it is expected that food fortification will soon become an important element of the country’s strategy to reduce micronutrient malnutrition.

# Section 3: Potential Food-Fortification Vehicles

## Edible Oil

### Production, Imports, and Consumption

Bangladesh produces between 400,000 and 450,000 metric tons (MT) of oilseeds per year, 50-60 percent of which is mustard-seed oil. Mustard-seed oil, soybean oil, and palm oil are the three major sources of edible oil; soybean oil and palm oil are imported.

As shown in table 3.1, Bangladesh has imported about 700,000 MT per year of soybean oil and palm oil since 2000-2001; these imports are refined in-country. Per capita consumption of the two categories of oil was 14g/day on average over the same period. Since mustard-seed oil is not suitable for fortification, it was omitted from the calculations.

**Table 3.1 Soybean and Palm Oil in Bangladesh: Imports and Consumption, 1999-2003 (MT)**

| Year | Imports | | Population (million) | Consumption | |
|---|---|---|---|---|---|
| | Soybean Oil | Palm Oil | | Total* | Per Capita (g/day) |
| 1999-2000 | 387,892 | 107,596 | 121 | 468,561 | 10 |
| 2000-2001 | 600,832 | 249,569 | 131 | 802,890 | 17 |
| 2001-2002 | 478,265 | 387,455 | 133 | 914,685 | 17 |
| 2002-2003 | 301,048 | 345,928 | 135 | 607,709 | 12 |
| **Average** | **442,009** | **272,637** | **132** | **673,461** | **14** |

* Extraction rate: 95 percent for soybean oil and 93 percent for palm oil

Source: calculations using data from the National Board of Revenue (Ministry of Finance)

Table 3.1 shows that per capita consumption of soybean oil and palm oil was 10g/day in 1999-2000. This estimate is consistent with results in the Bangladesh Bureau of Statistics survey, which estimates per capita edible oil consumption (all types of oil) at 12.82g/day in 2000. As indicated in the same survey, even though per capita oil consumption is higher in urban areas than in rural areas, per capita oil consumption in rural areas is only slightly lower than 90 percent of the national average (11.24/g/day and 12.82g/day, respectively).

Table 3.2 presents per capita oil consumption estimates (for all types of oil) by age group and gender. The table reveals two characteristics: first, per capita consumption is higher for higher age groups; second, per capita consumption is significantly higher (about 45 percent) for men than for women. The two consumption characteristics apply to both rural and urban areas.

It is also important to note that per capita consumption of soybean oil and palm oil has been rapidly increasing in recent years. As shown in table 3.1, per capita consumption has been 14g/day on average since 2000-2001, and was as high as 17g/day in 2000-2001 and 2001-2002.

**Table 3.2. Oil Consumption Patterns in Bangladesh (g/day)**

| Age Group & Gender | Rural | Urban | All |
|---|---|---|---|
| 1-3 years | 2 | 2.5 | 2.1 |
| 4-6 years | 4 | 6.5 | 4.5 |
| 7-9 years | 4.8 | 7.8 | 5.4 |
| Female | 7.1 | 13.4 | 8.4 |
| Male | 10 | 20.3 | 12.1 |

Source: Jahan and Hossein 1978

### Soybean Oil and Palm Oil Processing

Only unrefined soybean oil and palm oil are imported, and imports are processed by a limited number of producers. Interviews conducted for this study indicate that there are about 50 oil producers in Bangladesh, of which 15 are active. Three large producers — with an individual capacity of over 500 MT/day — process 80-90 percent of all soybean-oil and palm-oil imports.

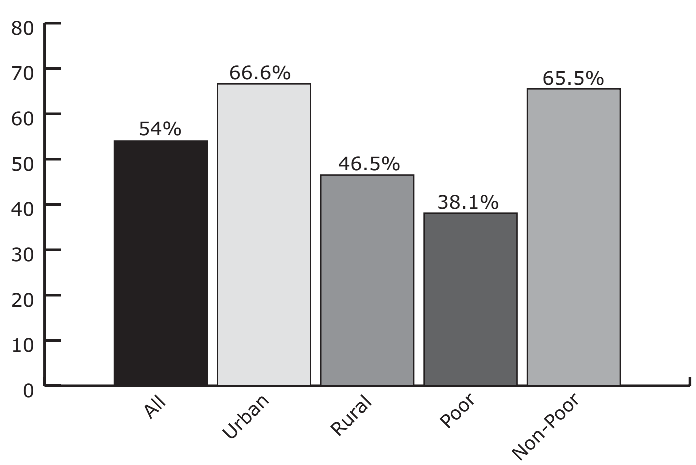
## Wheat Flour[1]

### Wheat Production and Imports

Wheat is cultivated mainly in the country's northern and western regions, two areas less prone to flooding. During 1995-2001, domestic production averaged about 1.7 million MT, while imports averaged about 1.4 million MT. In the past four years, average production has been about 1.4 million MT and average imports about 1.5 million MT. Thus, total annual wheat supply in Bangladesh has been about 3 million MT per year.[2]

Domestic wheat production expanded at 7.8 percent per year, on average, in 1987-2001, and imports declined by 1.7 percent annually during the same period. This trend was reversed in recent years, however. Over the past four years, average annual production declined by 3 percent, while average annual imports increased by 16 percent.

**Average Daily Wheat Consumption, 1999**




Wheat imports in Bangladesh fall into three main categories: imports by the private sector, imports by the government's Public Food Distribution System, and imports by foreign donors.

At the start of the 1990s, foreign donations accounted for virtually all imports. However, since 1991-92 (date at which they were first permitted), private-sector (commercial) imports have increased steadily, while the proportion of foreign donations has declined. During the same period, government commercial imports through the Public Food Distribution System have been negligible. For the past three years, the private-sector's share of total imports has been three-quarters. The fact that private sector imports have been steadily increasing in the face of the decline in foreign donations suggests that the wheat sector is becoming more of a private-market activity in Bangladesh.

### Wheat-Flour Consumption

As a source of energy and protein in Bangladesh, wheat ranks second in importance after rice, although representing only 10-15 percent of total cereal consumption (FAO 2002). Wheat consumption is more important in urban areas than in rural areas. A 1999 survey of food consumption patterns indicates that overall consumption averages 54g/day/person of wheat or 43g/day/person of wheat flour. Calculations using data in WFP 2004 indicate that total consumption has averaged about 56g/day/person of wheat or 45g/day/person of wheat flour in the past four years. The 1999 food-consumption survey reports an average daily per capita wheat consumption of 66.6g in urban areas and 46.5g in rural areas (equivalent to 53g and 37g of wheat flour, respectively). The same survey reports separately for families classified as poor and non-poor. Daily wheat per capita consumption was 38.1g for the poor and 65.5g for the non-poor (equivalent to 30g and 52g of wheat flour, respectively). Results are summarized in the figure to the left.

1 This section on wheat flour draws on Rassas and Fitch 2002

2 All production and import data are calculated from FAO; WFP 2001; and WFP 2004

Wheat is consumed primarily in flat breads known as *chapatis* and *parotas*, although raised breads and pastries — often from bakeries — are also consumed in urban areas. The flat breads are made with whole-wheat flour known as *atta*, whereas breads and pastries are made with various grades of white flour known as *maida*.

## Production Technology

There are essentially two types of flour mills in Bangladesh: traditional *chakki* mills and roller mills. *Chakki* mills are small stone mills, usually located in rural markets and in some urban commercial centers. Although the exact figure is unknown, there are commonly reported to be thousands of *chakki* mills in Bangladesh.

*Chakki* mills, many imported from India, produce whole-wheat flour. These mills typically have the capacity to grind a few tons of grain per day and operate on demand, as customers bring in grain for milling.

Roller mills are the main source of flour for urban consumers, and most of those mills are located in or near urban centers, particularly in the industrial areas of greater Dhaka and Chittagong. According to recent studies, there are about 260 roller mills in Bangladesh. These mills tend to be much larger than *chakki* mills. It is reported that while daily milling output of the roller mills ranges from 20 to 150 MT of wheat, nearly all have capacities of over 50 MT/day.

## Products

Products of the mills vary depending upon their markets and upon the capacity of their equipment. It appears that all mills produce some combination of three basic items: *maida*, *atta*, and bran. Most mills also produce a small amount of *souji* (farina), which is used for confections and pastries made for special occasions. A certain amount of bran is added back to *maida* to make *atta*, and the rest of the bran is sold for cattle feed. Mills with more-sophisticated equipment often make two or three grades of *maida* — with the whitest going as their premium quality — while other mills make two grades of *atta*.

Depending upon the technical characteristics and commercial objectives of the mill, the product mix varies within the following ranges, as a percent of the original grain weight:

| | |
|---|---|
| *Maida* | 60-65% |
| *Atta* | 20-25% |
| *Souji* | 2-3% |
| Bran | 15-20% |
| Refraction (milling loss) | 1-4% |

*Atta* produced by roller mills is different from that produced by *chakki* mills in that it normally contains less bran. It also varies in nutritional content, according to how it is made. Some mills appear to use only the mill's highest "ash stream," sometimes called "red dog," which has very high mineral and vitamin content. Other mills produce a "premium" (lighter color) *atta* that contains more *maida*, but a reduced micronutrient content.

## Market Structure

Since the *chakki* mills operate primarily as custom mills (grinding wheat for individual customers), commercial marketing of wheat flour is mostly an activity of the roller mills. Roller mills produce mainly for the urban market, but they also sell flour to merchants and restaurants in rural areas, particularly those within reach of the mills' location.

The exact size of the market served by the roller mills is not well understood. Within the industry itself, it is often said that roller mills account for over half the flour consumed in the country. But it is also said that roller mills produce primarily for the urban market. What is not known is the extent to which roller-mill flour penetrates the rural market.

Bangladesh's transport system places limitations on the marketing area that any given mill can serve. Nevertheless, roller-mill flour does reach into rural markets to some extent. It is estimated that about one-third of the flour produced by roller mills is sold to rural consumers. It is also estimated (Rassas and Fitch 2002) that roller-mill production accounts for about 48 percent of the wheat flour consumed in Bangladesh.

## Sugar

### Production

In Bangladesh, sugar production is based upon the sugarcane industry, which produces over 7 million MT of sugarcane annually over an area of 180,000 hectares in the north-west and south-west. It is estimated that about 0.5 million farmers are involved in sugarcane production. Sugarcane farming is supported by the Bangladesh Sugar Research Institute, headquartered in Ishurdi, Pabna, about 250 km north-west of Dhaka. The Institute conducts research on sugarcane, *gur* (molasses), and cane juice. Its mandate is to develop and disseminate new sugarcane varieties and improved production technology.

**Table 3.3: Sugar Production in Bangladesh, 1993-94 (MT)**

| Year | Capacity | Production |
|---|---|---|
| 1993-94 | 202,050 | 221,547 |
| 1994-95 | 198,440 | 270,196 |
| 1995-96 | 195,440 | 183,934 |
| 1995-96 | 210,440 | 135,320 |
| 1995-96 | 210,440 | 166,457 |
| 1998-99 | 210,440 | 152,979 |
| 1999-00 | 210,440 | 123,498 |
| 2000-01 | 210,440 | 98,355 |
| 2001-02 | 210,440 | 204,329 |
| 2002-03 | 210,440 | 177,399 |
| 2003-04 | 210,440 | 119,390 |

Source: BSFIC

Although sugar production averaged about 170,000 MT in the past 10 years and about 145,000 MT in the past five years, it has fluctuated widely — particularly in recent years (table 3.3).

Sugar is produced in 15 factories owned by the Bangladesh Sugar and Food Industries Corporation (BSFIC), a state-owned company. BSFIC employs almost 17,000 workers and purchases its sugarcane through a contract-farming scheme that provides credit to farmers in the form of inputs and cash.[3]

Since 1995-96, competition with *gur* producers, together with fluctuation in sugarcane production, has resulted in underutilization of BSFIC plant capacity (table 3.3). Excess capacity averaged almost 60,000 MT/year in the past ten years and more than 80,000 MT/year in the past five years.

Total production and official imports in the past four years were about 410,000 MT per year on average (tables 3.3 and 3.4), equivalent to an average daily consumption of 8.5g. This consumption figure is in line with estimates derived from national nutrition-survey data. For instance, per capita sugar consumption is estimated at 7g/day in Jahan and Hossain and ranges between 6.85g/day and 9.2g/day in Bangladesh Bureau of Statistics 2001.

**Table 3.4. Official Sugar Imports in Bangladesh, 1990-2003 (MT)**

| Year | Government | Private Sector | Total |
|---|---|---|---|
| 1999-00 | 147,000 | 102,140 | 249,140 |
| 2000-01 | 98,972 | 183,884 | 282,856 |
| 2001-02 | 125,350 | 132,622 | 257,972 |
| 2002-03 | 26,250 | 231,126 | 257,376 |

Source: government import-data are from the BSFIC; private import data are from the National Board of Revenue, Ministry of Finance.

### Imports and Consumption

Only white sugar is imported in Bangladesh. Official imports averaged slightly more than 260,000 MT in the past four years (table 3.4). All sugar imports have been channeled through the private sector, except during a five-year period extending from 1998-99 to 2002-2003. BSFIC has yet to import any sugar in 2003-2004.

3 Contract farming is an institutional arrangement between farmers and buyers in which farmers supply produce according to specified production and management methods, while buyers retain responsibility for marketing operations and technical assistance.

The similarity between estimates based on trade data and those derived from national nutrition-survey data suggests that unofficial sugar imports in recent years have been negligible. This conclusion is at variance with the commonly held view in Bangladesh that unofficial cross-border sugar imports are significant. A possible explanation for the divergence is that sugar imported through informal channels tends to decline substantially in years when BSFIC is active in the sugar trade. Although BSFIC imported an average of 100,000 MT per year between 1999-00 and 2002-03, it did not import any sugar before 1998-99, nor does it intend to import any sugar in the current year. A longer time-series would undoubtedly show that official imports increase as BSFIC ceases or otherwise reduces sugar-import activities. However, a comparison of BSFIC and unofficial imports is unlikely to show an inverse relationship, since private imports are expected to substitute for at least part of BSFIC imports.

As can be derived from tables 3.3 and 3.4, local sugar production in Bangladesh is estimated at 20-25 percent of total sugar consumption. This finding points to an important conclusion: since only local production can be fortified, per capita consumption of fortified sugar would be proportionately lower than current per capita sugar consumption, and the vast majority of the population would not have access to the fortified product.

Per capita consumption of fortified sugar in rural areas would be even lower, reflecting the country's current geographic consumption patterns. According to the Bangladesh Bureau of Statistics, sugar consumption in 2000 was 8.78/day in urban areas but only 6.37g/day in rural areas. Such differences in consumption are further detailed in table 3.5.

**Table 3.5. Sugar Consumption Patterns in Bangladesh in 1995-96 (g/day)**

| Age Group & Gender | Rural | Urban | All |
|---|---|---|---|
| 1-3 years | 6.3 | 10.8 | 7.2 |
| 4-6 years | 4.7 | 6.0 | 5.0 |
| 7-9 years | 7.8 | 7.7 | 7.8 |
| Female | 5.6 | 6.8 | 5.8 |
| Male | 10.0 | 10.0 | 10.0 |

Source: Jahan and Hossein 1998

Per capita consumption of fortified sugar in rural areas is likely to be much lower than the national average for two reasons: per capita sugar consumption in rural areas is lower than in urban areas, and also *gur* — a form of molasses not suitable for fortification — represents a significant component of sugar consumption in rural areas.

# Section 4: Cost Analysis of Food Fortification

## Rationale

Information on fortification costs can be useful to decision-makers in assessing the fortification program's potential economic impact on consumers. Such information may, for instance, be used to ascertain whether price increases associated with fortification will be relatively low and thus not affect consumers adversely. In particular, cost information may be used to confirm that, while consumption of the fortified food will have positive health effects on consumers, the price increase will not place it beyond the reach of the most vulnerable segments of the population.

Cost information is equally important for the private sector. Mill owners, oil refiners, and sugar producers will make more-informed decisions when cost information is readily available. Knowledge of fortification costs is all the more important under voluntary fortification because producers need an advance determination that fortification can be put into operation at a price consumers are willing to pay. Factory owners also need information on the potential adjustments that may be required in terms of plant redesign, new equipment, and personnel.

## Results

Fortification of wheat flour, oil, and (to a certain extent) sugar requires very little modification of the usual processing operations and is relatively simple and inexpensive. The main costs of fortification are those of the micronutrients. The cost of the equipment used to incorporate micronutrients into the food vehicle will depend on the sophistication of the system adopted and on the design and capacity of the processing plant. A limited amount of labor is required to operate the equipment and manage the fortificant, as well as to implement the necessary quality-assurance and quality-control procedures. There are also costs associated with testing for quality assurance — daily within the plant and periodically by outside organizations.

A summary of the unit costs of fortification appears in table 4.1, with detailed calculations provided as annexes to this study. The annexes estimate fortification costs in terms of total expenditure incurred by processors as well as per MT of fortified flour.

### *Total fortification costs*

As shown in table 4.1, total cost of fortification is estimated at about Tk223 ($3.85) per MT for oil, Tk295 ($5) per MT for wheat flour, and Tk630 ($10.8) for sugar. Fortification costs, including vitamin A, are estimated at 0.46 percent of (weighted) retail price for oil (0.43 percent for soybean oil and 0.53 percent of palm oil); 1.6 percent of the retail price for flour (*maida*) in plastic bags; and 2.09 percent of the retail price for sugar. Such estimates suggest that the additional cost of fortification does not appear prohibitive to consumers, particularly in the case of oil, where the increase is particularly modest.

Cost figures presented in table 4.1 do not include the 47 percent import duty currently imposed on micronutrients, and taking the import tax into consideration would raise the costs of fortification substantially. As shown in table 4.2, incorporating such a tax into the calculations would raise the cost of fortification to $5.62/MT for oil, $7.21/MT for wheat flour, and $16.08/MT for sugar, with a proportionate increase in retail prices for the three commodities. This conclusion suggests that it might be wise to consider eliminating the import duty on micronutrients.

**Table 4.1. Fortification Costs for Wheat Flour, Oil, and Sugar in Bangladesh**

| Item | Cost per Metric Ton | | | | | |
|---|---|---|---|---|---|---|
| | Wheat Flour | | Oil | | Sugar | |
| | Tk | Dollar | Tk | Dollar | Tk | Dollar |
| Capital Costs | 15.1 | 0.26 | 3.3 | 0.06 | 29.8 | 0.51 |
| Maintenance & Repair | 0.9 | 0.02 | 0.2 | — | 1.7 | 0.03 |
| Electric Power | 0.5 | 0.01 | 0.4 | 0.01 | 3.5 | 0.06 |
| Labor | 0.6 | 0.01 | 0.2 | — | 1.0 | 0.02 |
| Testing at Factory | 10.6 | 0.18 | 5.8 | 0.10 | 11.6 | 0.20 |
| Outside Testing | 2.8 | 0.05 | 1.5 | 0. 03 | 2.6 | 0.04 |
| Vitamin A or Premix | 264 | 4.55 | 215.2 | 3.71 | 606.9 | 10.46 |
| Fortification Cost | 294 | 5.07 | 223 | 3.85 | 627 | 10.81 |

Note: — denotes a negligible amount

**Table 4.2. Fortification Costs for Wheat Flour, Oil, and Sugar in Bangladesh with the Current Import Duty on Micronutrients**

| Commodity | Fortification Costs (dollar/MT) | Percent of retail price |
|---|---|---|
| Oil | 5.55 | 0.62 |
| Wheat Flour | 7.21 | 2.3 |
| Sugar | 15.93 | 3.08 |

*Micronutrients*

While vitamin A is the only ingredient added to oil and sugar, fortified wheat flour contains thiamine, riboflavin, niacin, folic acid, iron, and zinc — in addition to vitamin A.

At 90-95 percent of total fortification costs, the premix[4] is the single largest component of those costs. It is worth noting that since the cost of vitamin A is about 50 percent of premix cost for wheat flour, reducing the amount of vitamin A in the wheat flour would lower the cost of the premix significantly.

*Fortification equipment*

Micronutrient mix is metered into the stream of the fortified commodity as it flows through a conveyor or pneumatic transfer spout near the end of the processing operation. Incorporating micronutrients into the food vehicle requires a mixer, blender, or similar equipment and a special automatic feeder with a flow-rate-control device — regulated by either weight or volume — that causes the addition of the micronutrient mix to vary with product flow on the line.

The feeder tank contains paddles or other agitators to ensure that the micronutrient mix flows evenly and does not clog. The feeder is usually equipped with electrical or electronic safeguards to ensure that the line is stopped if the flow of micronutrient mix is insufficient or excessive, or when the flow of product on the line is inadequate to permit uniform mixing. In the case of sugar, the micronutrient mix is first diluted with a certain amount of sugar inside a batch blender. The combination of micronutrient mix and a given amount of sugar is called premix.

Total annual costs of the fortification equipment, including investment, maintenance, repairs, and energy, are estimated at Tk16.5 ($0.29) per MT for wheat flour, TK35 ($0.60) for sugar, and Tk4 ($0.07) for oil.

It is worth noting that annual investment costs of the fortification equipment will depend not only on the purchase price of such

4 A premix is a combination of the micronutrients themselves and another ingredient (often the same food to be fortified) to improve the combination of the micronutrient mix in the food and reduce the segregation between the food and micronutrient particles.

equipment, but will also and more importantly reflect the economies of scale associated with factory output.[5]

### *Quality assurance and quality control*

Quality assurance refers to systematic implementation of a set of activities to ensure that the fortified food will meet quality standards. Quality control refers to the techniques and activities that document compliance with the technical requirements of food-fortification through the use of objective, measurable indicators.

Each producing factory has a quality-assurance department responsible for inexpensive, semi-quantitative testing carried out at regular intervals while the mill is in operation. Tests are run shortly after the samples are taken so that problems can be detected and corrected as they occur. A portion of each sample is saved for possible verification tests by food-control authorities. The premix received from the manufacturer is also sampled and tested to confirm quality. Quality-control personnel are responsible for maintaining records of the testing as well as of the quantities of premix used and fortified commodity produced. Periodically, samples are sent to outside laboratories to confirm quality and conformity with technical specifications.

As indicated in table 4.1, the costs of testing are low for wheat flour (Tk13 or $0.23 per MT) and oil (Tk 7.3 or $0.13 per MT), and slightly higher for sugar (Tk 14.2 or $0.24 per MT).

### *Labor*

Additional labor is required to operate and monitor the fortification equipment and to add the micronutrient premix to the feeder. Additional personnel are also required to carry out the various quality-control and quality-assurance procedures, including regular sampling and testing of the fortified food. Ranging between Tk0.2 for oil and Tk0.6 for wheat flour, labor costs per MT are negligible for all commodities under consideration.

5 Economies of scale in production occur because both investment and operating costs per unit of output tend to decrease as quantity processed increases. For instance, investment costs of the equipment per unit of fortified food are expected to be lower for factories with larger production capacity since the same equipment may be used in smaller factories to produce a smaller output. Similarly, per unit labor costs decline with size because additional labor is marginal in a large plant relative to a smaller plant.

# Section 5: Elements of a National Food-Fortification Program

## Food Vehicles and Fortification Regime

### Oil

*Oil is a most suitable food-fortification vehicle in Bangladesh*. Per capita consumption, the structure of the processing industry, and low fortification costs provide a strong rationale for such a conclusion. Analysis of the marketing system for oil indicates that *mandatory fortification would be the optimal option*.

#### *Consumption*

Mustard-seed, soybean, and palm oils are the country's three major sources of edible oil. Since mustard-seed oil is not suitable for fortification, the fortification program should concentrate on soybean oil and palm oil. Per capita consumption of soybean oil and palm oil is both adequate and rapidly increasing. As detailed in section 4, fortified at a minimum vitamin A level of 20mg/kg, consumption of 13g/day/person of oil would supply about 52 percent of EAR — an amount expected to have a significant biological impact. Per capita consumption increased from 10g/day in 1999-2000 to 14g/day on average between 2000-2001 and 2002-2003, and rose as high as 17g/day in 2000-2002.

Oil is consumed in adequate amounts in both rural and urban areas. Although per capita oil consumption is higher in urban areas than in rural areas, the difference is not substantial. A 2000 household income and expenditure survey (Bangladesh Bureau of Statistics 2001) shows that per capita oil consumption in rural areas is only slightly lower than 90 percent of the national average (11.24g/day in rural areas and 12.82g/day nationwide).

#### *Industry Structure*

Soybean oil and palm oil, which are imported in an unrefined form, are processed by only a limited number of producers. Of the 15 active oil producers in Bangladesh, only 3 have an individual capacity of more than 1000 MT/day, and these producers process 80-90 percent of all soybean and palm oil imports. Both the size and limited number of producers suggest that mandatory fortification for oil would be the most-effective strategy.

#### *Cost*

At Tk 223, or $3.81 per MT, oil has the lowest fortification cost among the three commodities considered — about 20 percent below wheat-flour fortification cost and well below sugar fortification cost. In addition, total fortification costs, including vitamin A, are estimated at 0.46 percent of retail price for oil — 0.43 percent for soybean oil, and 0.53 percent of palm oil.

### Wheat Flour

*Wheat flour is a suitable food-fortification vehicle in Bangladesh*. This conclusion is supported by wheat-flour consumption levels and patterns, relatively low fortification costs, and the structure of the milling industry. As detailed below, the wheat-flour fortification program should rely on roller mills, not on *chakki* mills and should also be private-sector driven and *voluntary*.

### *Consumption*

Per capita wheat-flour consumption is estimated at 43g/day. Although per capita wheat-flour consumption in urban areas is higher than in rural areas, per capita consumption in rural areas (about 38g/day) is only 15-20 percent lower than the national average. As explained in section 4, fortification of wheat flour would supply an adequate amount of about 20 percent of the EAR for vitamin A, iron, folate, B-12, B-1, B-2, B-6, niacin, and zinc.

### *Fortification Costs*

As detailed in the previous section, fortification costs for wheat flour are about Tk293, or $5 per MT, and represent about 1.6 percent of retail prices; these figures suggest that the additional cost of fortification does not appear prohibitive to consumers.

### *A Private-Sector-Driven Program*

The pilot wheat-flour fortification program was implemented in collaboration with the World Food Program (WFP) in support of the Vulnerable Group Development (VGD) program. Fortified *atta* for the VGD program is produced in special *chakki* mills that have been constructed with equipment (including micronutrient feeders) imported from Denmark. These mills are operated by NGOs, under the close supervision of USAID and WFP. While this arrangement may be suitable for the limited production envisaged under the ongoing pilot activity, no mechanism is now in place that will allow production to expand beyond the VGD program or to continue beyond WFP's current programming cycle.

There are two reasons for concluding that the current approach of producing fortified flour in small *chakki* mills operated by NGOs is neither institutionally viable nor economically sustainable under a larger-scale program. First, if the fortification of wheat flour is to expand on a sustainable basis, it must be embedded in the prevailing flour-production and -marketing system. Passed on to consumers, the costs of fortification will be reflected in somewhat higher flour prices. Since the flour market in Bangladesh is driven by a vibrant and highly competitive private sector, any flour-fortification program should build on this private-sector-based structure.

Second, due to the small size of the *chakki* mills, their large number, and their distribution in remote and scattered locations in rural areas, they are difficult to regulate. It should be added that less-refined *chakki*-mill flour contains larger quantities of natural vitamins and minerals than does the refined roller-mill *maida*.

### *A Roller-Mill Driven Manufacturing Method*

Milling capacity is a critical factor in determining the ease and method of fortification. Evidence from other countries suggests fortification at medium (25–150 MT/day) and large mills (>150 MT/day) to be most appropriate, whereas the feasibility and effectiveness of fortification at smaller stone or hammer mills has yet to be established. Large mills invariably have more-modern equipment and a higher technical capacity to integrate the fortification technology. Larger mills can also more easily amortize start-up costs and take advantage of various economies of scale in production and marketing.[6]

*Chakki* mills in Bangladesh typically have the capacity to grind only a few tons of grain per day, whereas the capacity of roller mills ranges from 20 to 150 MT/day. The fact that many of the roller mills are already using plastic packaging and engage in advertising based on product quality also makes roller mills a logical place to initiate commercial fortification.

6 See previous footnote

Although roller mills represent the only practical means of introducing flour fortification on a sustainable basis, it must be recognized that this will initially limit rural access to the fortified product, since most rural consumers obtain their flour through *chakki* mills. In the longer run, as the economy develops further and as transportation improves, it is likely that Bangladesh will follow the same pattern that has been observed in other countries: roller mill production will expand and account for an increasing share of the rural market. As that occurs, fortified flour will further extend into rural areas.

#### *A Voluntary, not Mandatory, Program*

The number of mills, their size, and the extent to which flour milling is centralized will determine whether a mandatory or voluntary program is the better option. The structure of the milling industry in Bangladesh suggests that a mandatory flour-fortification program will not be realistic for two reasons. First, the smaller mills, especially those located in rural areas, typically will lack the capital resources needed to participate in the fortification program. Second, implementation of a quality-control system will not be possible when most participants consist of a large number of small mills scattered throughout the country.

### Sugar

The case for sugar fortification in Bangladesh is based on two major arguments, the first being that the country has only 15 sugar factories, which would make program coordination and quality-control systems easy to implement. The second argument is that the BSFIC, a state-owned company, operates all those factories.

However, strong evidence presented in this study suggests that *sugar fortification in Bangladesh is not recommended*. This conclusion is supported by a combination of very low per capita consumption and relatively high fortification costs.

#### *Consumption*

The bulk of sugar consumed in Bangladesh is imported in an already refined form, thus placing severe limitations on the amount of sugar available for fortification. Local production is only about 20-25 percent of total sugar consumption, equivalent to less than 2g/day/person. Moreover, per capita sugar consumption in rural areas — where most of the vulnerable groups can be found — is much lower than in urban areas. Increased competition between sugar and gur (molasses) in recent years has put additional pressure on per capita sugar consumption in rural areas.

#### *Cost*

At about Tk630, or $10.8 per MT, the cost of sugar fortification is more than twice as high as that for wheat flour and nearly three times as high as for oil. The additional cost associated with fortification would lead to an increase of over 2 percent in the retail price of sugar. Assuming fortification costs are passed on to consumers, this increase may place fortified sugar at a disadvantage relative to the imported unfortified product. Only a shift in demand for local sugar — stimulated, for instance, by a strong promotion and health-education campaign — would enable fortified-sugar production to compete with unfortified private-sector imports.

## Fortification Formulation

Table 5.1 describes the fortification formulation and micronutrient supply for oil and wheat flour in Bangladesh. Fortified at a minimum vitamin A level of 20mg/kg, oil would supply about 52 percent of EAR — an amount expected to have a significant biological impact.

Based on the formulation described in table 5.1, fortification of *maida* would supply about 20 percent of EAR for vitamin A, iron, folate, B-12, B-1, B-2, B-6, niacin, and zinc.

**Table 5.1: Fortification Formulation and Micronutrient Supply for Wheat Flour (Maida) and Oil in Bangladesh**

| Nutrient | Form | Minimum Level of Addition (mg/kg) * | Overage (%) ** | % EAR in Usual Consumption *** |
|---|---|---|---|---|
| | | **Wheat Flour** | | |
| Vitamin A | SD250 | 2 | 50 | 16 |
| Iron | Ferrous fumerate | 45 | 5 | 20 |
| Folate | Folic acid | 2 | 50 | 23 |
| B-12 | B-12 — 0.01% | 0.010 | 30 | 18 |
| B-1 | Thiamin mononitrate | 6 | 40 | 18 |
| B-2 | Riboflavin | 4 | 30 | 16 |
| B-6 | Pyridoxin | 5 | 20 | 19 |
| Niacin | Niacinamide | 40 | 10 | 16 |
| Zinc | Zinc oxide | 20 | 5 | 19 |
| | | Oil | | |
| Vitamin A | Vitamin A oily 1.7mIU/g | 20 | 5 | 52 |

**Notes:**

* Selected (1) to provide at least 20 percent EAR from 50g/day/person of wheat flour consumption, (2) to be compatible with the sensorial properties of the product, and (3) to be safe for those who consume large amounts of the product.

** The additional amount over the minimum level to compensate for losses in production, storage, and transportation.

*** 40g/day for wheat flour and 13g/day for oil; values for families, adult male.

## Packaging and Labeling

Packaging and product labeling play an important role in fortification, as some micronutrient additives degrade with exposure to heat, light, and other factors such as excessive moisture (in wheat flour, for example). Vitamins are affected by both heat and excessive moisture, while minerals tend to be affected to a lesser extent.[7] Certain packaging and labeling guidelines should therefore be followed for each product considered for fortification.

### Oil

Interviews with producers indicate that about 85 percent of oil produced in Bangladesh is sold in large tin cans, with the remainder sold in smaller plastic bottles. Processing plants have mechanical packaging machines that affix their own labels and promotional information on each can or bottle. Down the marketing chain, oil in tin cans is sold to retailers and small vendors, who then resell in smaller quantities to consumers from stalls at traditional markets throughout the country.

While fortified oil sold in tin cans is not likely to lose any of its micronutrient content, the shelf life of vitamin A in oil sold in transparent plastic bottles will be adversely affected by exposure to light. An important step in the oil-fortification program will be to replace the transparent plastic bottle with a more-opaque container to protect the micronutrient content.

### Wheat Flour

Wheat flour in Bangladesh normally has a moisture content of 13–16 percent. At these levels, significant loss of micronutrients would be expected to occur if fortified flour were stored for several months. Since flour in Bangladesh is rarely stored for more than a few weeks, micronutrient loss due to the presence of moisture is not expected to occur.

If mills were to produce dryer flour, with moisture content of 10 percent or less, it would be possible to store flour for longer periods of time, provided the low moisture levels could be maintained. For these purposes, it would be preferable to pack the

7 Sensitivity of vitamins and minerals to heat, light and similar factors are a few of the underlying reasons for selecting the overage figures in table 5. 1.

flour in plastic, which would prevent the flour from accumulating moisture from the humid air that normally prevails in Bangladesh. However, when the flour is being marketed within a short period, as is currently the case, plastic is not essential.

Accurate labeling is critical when fortification is not mandatory, as expected in the case of wheat flour in Bangladesh. When fortification is not mandatory, labeling is the only means by which consumers and inspectors can distinguish fortified flour from the regular product. Information contained in labeling can also be a useful part of promotion and consumer education.

Packaging material also plays an important role in labeling. It is easier to print detailed label information on plastic than on jute sack materials. Furthermore, it is common for the large sacks to be reused — a procedure that could lead to confusion and perhaps to deceptive practices by unscrupulous merchants, who could place regular flour in a sack that had been labeled as containing fortified flour.

For purposes of clear product identification, the small plastic bags would be a preferred method of packaging fortified flour. However, these bags are expensive and normally add one takka or more per kg to the retail price of flour, which would tend to place it out of the reach of poorer consumers. Large (25 kg) bags with plastic lining, such as those currently used by WFP under the pilot program, can be clearly labeled and, while they do cost more than the plain jute sacks, they cost less on a per-kilogram basis than small, individual plastic bags.

## National Capacity to Implement Food Fortification

There is fervent commitment to food fortification in Bangladesh at the highest level of government, and a strong public and private-sector partnership is emerging.

In December 2003, NFA was formed, consisting of over 30 members from the public and private sectors, civil society, and international development partners. Headed by the Minister of Industries, NFA includes the Principal Secretary, Prime Minister's Office, and Secretaries of the Ministries of Agriculture, Commerce, Health and Family Welfare, Food, and Science, Technology, and Information Communications.

NFA's private-sector members include the Presidents of the Vegetable Oil Refiners Association, the Oil Mill Refiners Association, and the Major and Compact Flour Mill Owners Association. International development partners are represented by USAID, WFP, UNICEF, World Health Organization, the Micronutrient Initiative, and the International Center for Diarrheal Diseases and Research.

A Technical Committee provides specialized support to NFA and its members. NFA held its first meeting in April 2004.

A rapid assessment conducted for this study indicates that Bangladesh has the necessary human and institutional capacity to implement food fortification on a national scale. However, available evidence suggests that while NFA partners are interested in food fortification, they will be unable to put the program into action without technical support. An integrated package of key technical-assistance interventions provided by the Global Alliance for Improved Nutrition, USAID, and other donors would help create the conditions for NFA partners to proceed. Technical-assistance interventions will be needed to implement all five component of food fortification: production and distribution, including industrial implementation and quality assurance/control; food control, including legislation, inspection and enforcement, and program testing and monitoring; communications and marketing; monitoring and evaluation; and program management.

# References


Bangladesh Bureau of Statistics. May 1999. Report of the Poverty Monitoring Survey. Dhaka, Bangladesh: Ministry of Planning, Statistics Division.

______. December 2001. Household Income and Expenditure Survey - 2000.

Food and Agriculture Organization. 2002. "Food Balance Sheets," Bangladesh. Annual sheets for 1985-1999. (Available from www.fao.org.)

Helen Keller International, Institute of Public Health and Nutrition. 2001. The Nutritional Surveillance Project in Bangladesh in 1999. Dhaka, Bangladesh.

Jahan, Khursheed, and Mosharff Hossain. July 1998. Nature and Extent of Malnutrition in Bangladesh: Bangladesh National Nutrition Survey, 1995-96. Dhaka, Bangladesh: Institute of Nutrition and Food Science, University of Dhaka

Mannan, Abdul, Mohammad, Mamunar Rashid, A.Z. Amanatullah, M. Eshaque Ali, and M. Shahjahan. 2002. Dhaka, Bangladesh: Bangladesh National Nutrition Council.

Ministry of Finance, Economic Relations Division. March 2003. Bangladesh:A National Strategy for Economic Growth, Poverty Reduction and Social Development. Dhaka, Bangladesh: Government of the People's Republic of Bangladesh.

Ministry of Health and Family Welfare. 1997. Dhaka, Bangladesh: Government of the People's Republic of Bangladesh.

Ministry of Health and Family Welfare, in Collaboration with the Bangladesh National Nutrition Council. 1997. Bangladesh National Plan of Action for Nutrition. Dhaka, Bangladesh: Government of Bangladesh

Rassas, Bechir and James Fitch. July 2002. Wheat Flour Fortification in Bangladesh: Cost Analysis and Sustainability Considerations. Arlington, VA: MOST, The USAID Micronutrient Program.

World Bank. 2002a. Bangladesh: Progress in Poverty Reduction. Background Paper, Bangladesh Development Forum, Paris, March 13-15, 2002. Washington, D.C.

World Bank. 2002b. Poverty in Bangladesh: Building on Progress. Washington, D.C.: Poverty Reduction and Economic Management Sector Unit, South Asia Region.

World Food Programme. January 2004. Bangladesh Food Grain Digest. WFP-Bangladesh.

______. December 2001. Bangladesh Food Grain Digest. WFP-Bangladesh.

______. July 2000. Report on Market Survey of Flour Mills of Bangladesh. WFP-Bangladesh.

# Annex Tables

| Annex A: Estimated Costs of Oil Fortification in Bangladesh | | |
|---|---|---|
| **Cost Item** | **Cost** | |
| | **TK** | **Dollar** |
| **Annual Costs** | | |
| **Investment Costs** | | |
| Purchase price (blender) | 1,160,000 | 20,000 |
| Handling, shipping, and insurance | 46,400 | 800 |
| Total cost, CIF Chittagong | 1,206,400 | 20,800 |
| Customs duty | 69,600 | 1,200 |
| Customs clearance and handling in Bangladesh | 24,128 | 416 |
| Subtotal cost, delivered to mill | 1,300,128 | 22,416 |
| Local handling, installation, and training | 195,019 | 3,362 |
| Total investment costs | 1,495,147 | 25,778 |
| Annual investment costs | 297,911 | 5,136 |
| **Variable Costs** | | |
| Operating costs of equipment | | |
| Maintenance and repair | 17,400 | 300 |
| Electric power | 34,800 | 600 |
| Other operating costs | | |
| Labor | 14,280 | 246 |
| Internal Testing | 522,000 | 9,000 |
| Outside testing | 139,200 | 2,400 |
| Vitamin A | 27,953,100 | 481,950 |
| Total variable costs | 20,076,480 | 346,146 |
| **Fortification Costs Per Metric Ton** | | |
| Annual capital Costs (depreciation & interest) | 3.3 | 0.06 |
| Maintenance and repair | 0.2 | 0.00 |
| Electric power | 0.4 | 0.01 |
| labor | 0.2 | 0.00 |
| Internal Testing | 5.8 | 0.10 |
| Outside testing | 1.5 | 0.03 |
| Vitamin A | 215.2 | 3.71 |
| Fortification cost | 223.3 | 3.85 |
| **Key Parameters and Assumptions** | | |
| **Item** | **Unit** | |
| Customs duty on imported equipment | 6% | |
| Annual plant capacity | 90,000 MT/year | |
| Equipment life | 10 years | |
| Interest rate | 15% | |
| Annual Maintenance as a % of equipment costs | 1.5% | |

| Annex B: Estimated Costs of Wheat-Flour Fortification in Bangladesh | | |
|---|---|---|
| **Cost Item** | **Cost** | |
| | **TK** | **Dollar** |
| **Annual Costs** | | |
| **Investment Costs** | | |
| Purchase price (buffer tank, flow rate control, etc.) | 2,973,398 | 51,354 |
| Handling, shipping, and insurance | 171,273 | 2,953 |
| Total cost, CIF Chittagong | 3,144,572 | 54,312 |
| Customs duty | 178,404 | 3,081 |
| Customs clearance, and handling in Bangladesh | 59,468 | 1,086 |
| Subtotal cost, delivered to mill | 3,382,544 | 58,480 |
| Local handling, installation, and training | 342,479 | 5,915 |
| Total investment costs | 3,725,022 | 64,395 |
| Annual investment costs | 742,218 | 12,819 |
| **Variable Costs** | | |
| Operating costs of equipment | | |
| Maintenance and repair | 44,601 | 770 |
| Electric power | 23,940 | 413 |
| Other operating costs | | |
| Labor | 28,800 | 497 |
| Internal Testing | 521,100 | 9,000 |
| Outside testing | 138,960 | 2,400 |
| Vitamin A | 11,199,189 | 193,423 |
| Total variable costs | 11,956,590 | 206,504 |
| **Fortification Costs Per Metric Ton** | | |
| Annual capital Costs (depreciation and interest) | 15.1 | 0.26 |
| Maintenance and repair | 0.9 | 0.02 |
| Electric power | 0.5 | 0.01 |
| labor | 0.6 | 0.01 |
| Internal Testing | 10.6 | 0.18 |
| Outside testing | 2.8 | 0.05 |
| Vitamin A | 263.7 | 4.55 |
| Fortification cost | 294.2 | 5.07 |
| **Key Parameters and Assumptions** | | |
| **Item** | **Unit** | |
| Customs duty on imported equipment | 6% | |
| Annual plant production of fortified flour | 49,000 MT/year | |
| Equipment life | 10 years | |
| Interest rate | 15% | |
| Annual Maintenance as a % of equipment costs | 1.5% | |

| Annex C: Estimated Costs of Sugar Fortification in Bangladesh | | |
|---|---|---|
| **Cost Item** | **Cost** | |
| | **TK** | **Dollar** |
| **Annual Costs** | | |
| **Investment Costs** | | |
| Purchase price (mixer and feeder) | 1,740,000 | 30,000 |
| Handling, shipping, and insurance | 69,600 | 1,200 |
| Total cost, CIF Chittagong | 1,809,600 | 31,200 |
| Customs duty | 104,400 | 1,800 |
| Customs clearance and handling in Bangladesh | 36,192 | 624 |
| Subtotal cost, delivered to mill | 1,950,192 | 33,624 |
| Local handling, installation, and training | 292,529 | 5,044 |
| Total investment costs | 2,242,721 | 38,668 |
| Annual investment costs | 446,867 | 7,705 |
| **Variable Costs** | | |
| Operating costs of equipment | | |
| Maintenance and repair | 26,100 | 450 |
| Electric power | 52,200 | 900 |
| Other operating costs | | |
| Labor | 14,280 | 246 |
| Internal Testing | 174,000 | 3,000 |
| Outside testing | 38,667 | 667 |
| Premix | 9,103,433 | 156,956 |
| Total variable costs | 9,382,579 | 161,769 |
| **Fortification Costs Per Metric Ton** | | |
| Annual capital Costs (depreciation & interest) | 29.8 | 0.51 |
| Maintenance and repair | 1.7 | 0.03 |
| Electric power | 3.5 | 0.06 |
| labor | 1.0 | 0.02 |
| Internal Testing | 11.6 | 0.20 |
| Outside testing | 2.6 | 0.04 |
| Premix | 606.9 | 10.46 |
| Fortification cost | 627.2 | 10.81 |
| **Key Parameters & Assumptions** | | |
| **Item** | **Unit** | |
| Customs duty on imported equipment | 6% | |
| Annual plant capacity | 90,000 MT/year | |
| Equipment life | 10 years | |
| Interest rate | 15% | |
| Annual Maintenance as a % of equipment costs | 1.5% | |

Bangladesh has the necessary human and institutional capacity to implement food fortification on a national scale. However, available evidence suggests that while NFA partners are interested in food fortification, they will be unable to put the program into action without technical support. An integrated package of key technical-assistance interventions provided by the Global Alliance for Improved Nutrition, USAID, and other donors would help create the conditions for NFA partners to proceed. Technical-assistance interventions will be needed to implement all five components of food fortification: production and distribution, including industrial implementation and quality assurance/control; food control, including legislation, inspection and enforcement, and program testing and monitoring; communications and marketing; monitoring and evaluation; and program management.