PROFILES

A Data-Based Approach to Nutrition Advocacy and Policy Development

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BASICS

BASICS

BASICS is a global child survival support project funded by the Office of Health and Nutrition of the Bureau for Global Programs, Field Support, and Research of the U.S. Agency for International Development (USAID). The agency's Child Survival Division provides technical guidance and assists in strategy development and program implementation in child survival, including interventions aimed at child morbidity and infant and child nutrition.

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Abstract

The PROFILES nutrition advocacy and policy development process uses current scientific knowledge to estimate the cost and effectiveness of proposed nutrition interventions. PROFILES estimates the impact on developmental indicators, such as mortality, morbidity, school performance, and labor productivity, using epidemiological and demographic models, and, using computer graphics, presents the results to decision makers. The program, with funding from major international donors, has been successfully applied in more than a dozen developing countries. This report relates the models, the applications and their results, and lessons learned.

Photograph courtesy of UNICEF/HQ92-0262/Goodsmith.

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Contents

Tables

Figures

Acronyms

BASICS	Basic Support for Institutionalizing Child Survival
DHS	Demographic and Health Survey
FNRI	Food and Nutrition Research Institute (Philippines)
HHRAA	Health and Human Resources Analysis for Africa
NCHS	U.S. National Center for Health Statistics
NCP	Nutrition Communication Project
NFNC	National Food and Nutrition Commission (Zambia)
SARA	Support for Analysis and Research in Africa
SD	standard deviation
U5	child under 5 years of age
UN	United Nations
UNICEF	United Nations Children’s Fund
USAID	United States Agency for International Development

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- The Mali application was funded by USAID through BASICS and Linkages and implemented by BASICS, Linkages, and the Mali Ministry of Health.

- The Philippines application was funded by the Asian Development Bank and USAID through NCP and implemented by NCP, the Philippines Department of Health, and the Philippines National Nutrition Council.

- The Senegal application was funded by USAID through BASICS and the HHRAA/SARA Project (contract no. AOT-0483-C-2178-00) and implemented by BASICS, Linkages, and the Ministry of Health.

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- The Micronutrient Initiative funded the development of special models and presentations involving micronutrients, and the Asian Development Bank funded the incorporation of PROFILES into its development initiative in seven Asian countries.

Many individuals contributed substantially to the development and applications of PROFILES. It is unfortunate that there is not space to recognize them all by name. The following individuals played a particularly important intellectual role in the development and application of PROFILES: Edward Abel, William Bender, Joanne Capper, Rolf Carriere, Eunyong Chung, Susan Eastman, Claudia Fishman,

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Executive Summary

Research now shows that investments in nutritional programs can contribute to economic growth and are cost-effective strategies for improving child survival and development. However, decision makers are not generally aware of this knowledge; therefore, effective advocacy is necessary to generate the financial and political support required to scale up from small pilot projects and to maintain successful national programs. To accomplish this aim, PROFILES, a data-based nutrition advocacy and policy development methodology, which includes a collection of computerized epidemiological models, was developed and applied in developing countries in Africa, Asia, and Latin America.

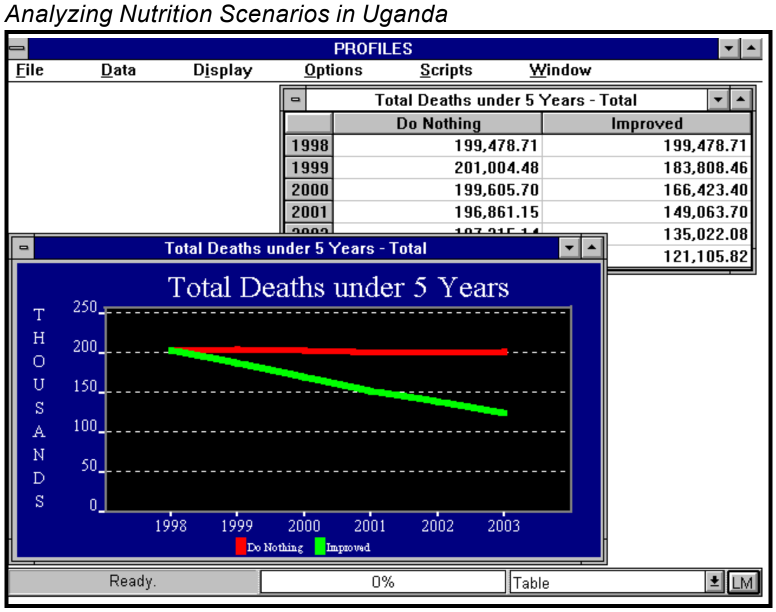
The PROFILES program uses current scientific knowledge to estimate the impact that nutritional improvements would have on important development indicators such as mortality, morbidity, fertility, school performance, and labor productivity. This report provides details about several of the models, including the impact of protein-energy malnutrition on child mortality; the volume and monetary value of breast milk; and the impact of childhood stunting, iodine deficiency during pregnancy, and adult iron deficiency anemia on labor productivity (see figure 1). The costs, coverage, and effectiveness of proposed programs are used to estimate changes in the nutritional conditions and behaviors, thus enabling estimates of program cost-effectiveness.

Figure 1.
Malian Schoolgirls: An Issue of Iodine

PROFILES has been applied in more than a dozen developing countries, including Bangladesh, Bolivia, Ghana, Mali, the Philippines, Senegal, Uganda, and Zambia. Figure 2 is a graphic analysis of the possible effects of two nutrition program alternatives in Uganda.

The application in Bangladesh contributed to the approval and funding of a major nutrition program. PROFILES was used to promote the nutrition component of an early childhood development program in the Philippines, and its early success led to its incorporation in a joint Asian Development Bank– UNICEF initiative to promote early child development in seven Asian countries. Partly as a result of the Ghana application, nutrition improvement became a top priority in a new national child survival strategy, and it attracted the attention of major donors. Experience to date suggests that successful applications require scientifically credible projections, estimated improvements large enough to attract the attention of policy makers and compete with alternative investments, and local champions that can sustain the advocacy for at least two to three years. The application of PROFILES in these countries and elsewhere has been supported by a wide range of agencies, including USAID, UNICEF, the World Bank, the Asian Development Bank, and the Micronutrient Initiative.

Figure 2.
Analyzing Nutrition Scenarios in Uganda



Introduction

Why PROFILES Is Needed

Recent experience clearly demonstrates that good nutrition can make significant contributions to both human and economic development in developing countries and that cost-effective approaches for improving nutrition are available (Martorell 1996; World Bank 1993). However, investments in nutrition programs have lagged behind other investments because (1) nutrition has been considered an *outcome from* rather than an *input to* development, and (2) nutrition programs have been viewed as less cost-effective than competing investments.

It is now possible to quantify these relationships with greater accuracy than was previously possible. For example, the meta-analysis of vitamin A trials by Beaton concluded that vitamin A supplements reduced child mortality by 23 percent in communities with high vitamin A deficiency (Beaton et al. 1993). The review of mortality effects of underweight status by Pelletier and colleagues (Pelletier 1994; Pelletier et al. 1993; Schroeder and Brown 1994) found a clear and consistent exponential relationship between severity of underweight-for-age and mortality in children aged 6 to 59 months. This allowed them to estimate that 56 percent of all child deaths in the world are associated with low weight-for-age. The meta-analysis by Bleichrodt and Born (1994) concluded that children born to women who reside in iodine-deficient areas have IQs 13.5 points lower on average than children in control areas. Victoria found a consistent pattern of increasing mortality in infants under 6 months of age as mothers moved farther away from the recommended practice of exclusive breastfeeding; infants fed only from a bottle were 18.3 times more likely to die from diarrhea and 2.9 times more likely to die from respiratory infection than exclusively breastfed infants (Victora et al. 1987).

The process of scaling up nutrition programs from small pilot projects to successful national programs is a challenging task that typically requires expansion in several dimensions, including financial and political (Uvin 1995). Furthermore, it is not sufficient to simply *attain* scale-up; it must be maintained. Competition for resources and political support can be intense at national levels, where more visible public health programs and other priorities outside the health sector vie for attention and funding, often with the support of their own groups of vocal and influential advocates.

In this competitive environment, effective advocacy is needed to acquire the resources and political commitment to scale up to the national level and then maintain the program. The new knowledge about the importance of good nutrition and the feasibility of achieving it, as well as the estimated impact of specific programs, must be communicated *effectively* to persons and organizations that influence nutrition investments, including grassroots organizations, local and national governments, and international agencies. Computer models with graphics is one technology that has been used successfully to commu-nicate information about social problems and influence policy. For example, the well-known computer simulations on world growth sponsored by the Club of Rome (Meadows et al. 1972) have been given credit for dramatizing the issue and stimulating serious discussion at the highest levels (Clark and Cole 1975), and the RAPID population growth model has been used to promote family planning programs in developing countries (Stover 1990; Porter 1995).

A Process for Policy Development and Advocacy

This report describes PROFILES, a data-based approach to nutrition policy development and advocacy that has been successfully applied in several developing countries. It is a process designed to demonstrate the contribution that improved nutrition can make to human and economic development and to influence the way policy makers think about public health nutrition issues and the priority they give to investing in nutrition programs.

At the heart of this approach is a set of computer models that translate nutrition data and scientific analyses into terms and arguments that make sense to nonexperts. The interactive computer models project the consequences of poor nutrition on mortality, morbidity, health care costs, worker productivity, mental development, fertility, and other developmental indicators; they also help to analyze the cost-effectiveness of programs that ameliorate poor nutrition. Examples from different countries illustrate key models, the process of application, and some results achieved from the applications.

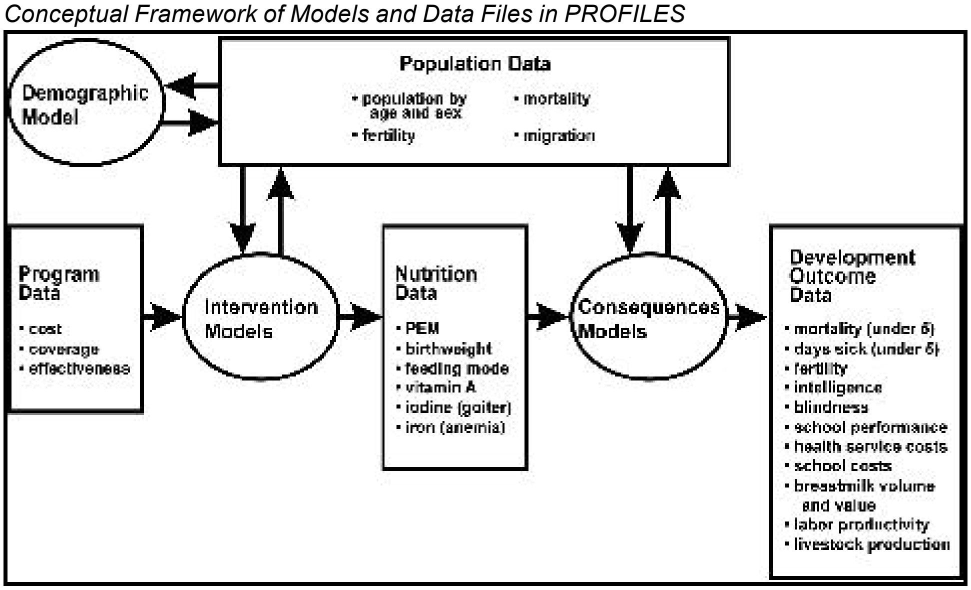
The PROFILES Program

Overview

PROFILES originated as a stand-alone software program in Borland Pascal for DOS (PROFILES 1) and Windows (PROFILES 2) that calculated and graphically displayed the consequences of nutritional deficiencies in a population. With use, it was developed into a package of software programs that form the core of the nutrition policy development and advocacy process. Later versions use commercial spreadsheet software for modeling and commercial presentation software for graphic communication. Relative to the original Pascal programs, the later software provides more transparency into the workings of the models, greater ease in modifying and adding models, and far greater access in Third World settings. Descriptions of these programs and the models used by them are described elsewhere, in detail (Abel 1992; Abel and Schoudt 1993; Burkhalter 1993a; Burkhalter et al. 1994).

The PROFILES computer program contains a set of linked models that calculate and display various developmental consequences of nutritional deficiencies in a population, as well as the estimated impact of proposed programs (see figure 3). Three types of models are used: (1) demographic, (2) intervention, and (3) consequence. The demographic model projects the size of the population by age and sex for up to 30 years in the future, based on trends in fertility, mortality, and migration.

Figure 3.
Conceptual Framework of Models and Data Files in PROFILES



Note: The three types of models in PROFILES (demographic, intervention, and consequence) use data from the four primary data files (population, program, nutrition, and development outcomes) to estimate future values of variables in the nutrition, population, and development outcomes data files.

The intervention models compute the effect of one or more proposed programs on various indicators of the nutritional condition of the population by considering program characteristics such as cost, coverage, and effectiveness. The consequence models calculate developmental outcomes as a function of the size, sex/age distribution, and nutritional condition of a population.

PROFILES has been used for various purposes: to estimate the consequences of nutritional deficiencies in a population, to estimate the cost-effectiveness of proposed nutrition programs, to effectively communicate these results to various audiences, and as a training approach. The multimedia features of PROFILES contribute to the communication and training objectives. During a presentation, information can be presented in a slide-show format showing predetermined sequences of screens containing graphs, tables, text, or pictures; or in an interactive format where the data and assumptions underlying the computations can be exposed and modified quickly to see the effects of the modifications on the developmental outcomes. Presentations often compare two scenarios with different assumptions (see figure 2 in the Executive Summary). For example, a “no change” scenario in which current nutritional status and practices remain unchanged might be compared to a proposed program that achieves year 2000 nutrition goals for a country in order to see the estimated benefits of achieving those goals.

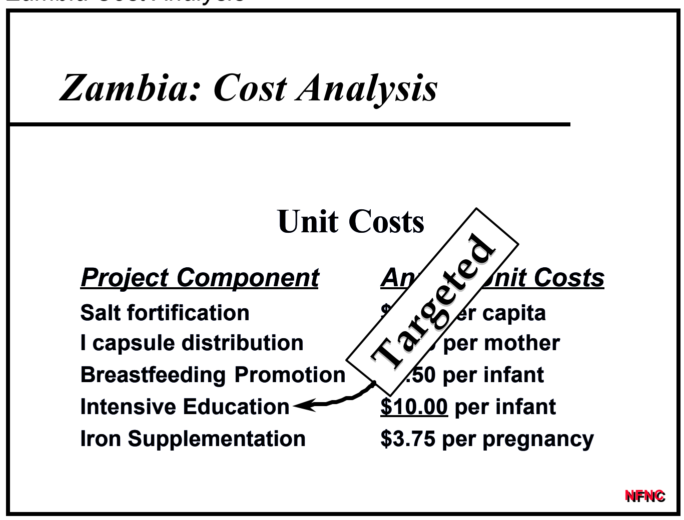
Demographic Model

PROFILES contains a standard cohort survival model in which the population at the end of a year equals the population at the beginning of the year after adjusting for births, deaths, and net migration during the year. Starting with a base year population distribution, PROFILES uses age-specific fertility rates and standard life tables (giving age- and sex-specific survival rates) to compute the births and deaths each year for up to 30 years. Annual net migration by age and sex must be entered directly. The PROFILES demographic model is based on the RAPID program (Stover 1990), which in turn is based on the model developed and used by the United Nations Office of Population (United Nations 1988). PROFILES also computes the number of deaths for each month of life during the first year of life (Burkhalter 1995). Typically, PROFILES applications use the fertility and mortality trends published by the United Nations (United Nations 1974, 1988, 1991), which are downward for most developing countries, reflecting the demographic transition.

Intervention Models

PROFILES characterizes nutrition programs by costs, coverage, and effectiveness, a structure based on concepts from Bender (1993), Grosse and Tilden (1988), and Ward (1993). *Annual costs* include fixed costs, maintenance costs that depend on the number of persons covered, and enrollment costs that depend on the number of new enrollees in the program that year (see figure 4).[1] Costs can also be identified by source: government, external donor, commercial, household cash, and household in-kind. *Coverage*, which typically starts low and grows as the program matures, is simply the fraction of persons in the primary target group reached by the program. *Effectiveness,* typically the most difficult type of program information to estimate or measure, is defined as the fraction of persons covered by a program who pass from a deficient state to a sufficient state as a result of the program. When nutrition programs address several nutritional deficiencies or several target groups, effectiveness can be estimated separately for the different deficiencies and groups in the different years of the program. The impact of a program on the nutritional status of a population is the product of coverage and effectiveness applied to the population.[2] This information enables an estimation of program cost-effectiveness and its presentation to decision makers. Details about this model are available (Burkhalter et al. 1994).

Figure 4.
Zambia Cost Analysis



Consequence Models

The consequence models are functions that calculate the value of various developmental outcomes (consequences) from population and nutrition data. They can be grouped into 11 categories: (1) child mortality, (2) child morbidity, (3) maternal mortality, (4) fertility, (5) vision, (6) intelligence, (7) school performance, (8) government health and education expenditures, (9) volume and value of breast milk, (10) labor productivity, and (11) other economic consequences.

PROFILES includes six types of nutritional conditions, including: (1) protein-energy nutrition in children, (2) maternal nutrition and birth weight, (3) child feeding practices, (4) vitamin A status in children, (5) iodine status, and (6) iron deficiency anemia. The prevalence (or incidence) of each condi-tion in the population is described, usually by level of severity. For example, protein-energy nutrition in children is characterized by eight nutrition variables: the prevalence of normal, mild, moderate, and severe weight-for-age status in children under 5 years of age (U5s) and the prevalence of normal, mild, moderate, and severe height-for-age status at age 2 years. In this example, weight-for-age and height-for-age are called *indicators* and apply to individuals, whereas the prevalence of normal, mild, moderate, and severe status are called *variables* and they apply to the population. Appendix 1 summarizes the nutri-tional indicators and variables used by PROFILES.

Several different nutritional conditions can influence a single developmental consequence; therefore, the PROFILES consequence functions generally include several nutritional conditions as independent variables and one consequence as the dependent variable, thus allowing PROFILES to estimate the consequences of simultaneous changes in several nutritional conditions. Some of the consequence

functions include socioeconomic parameters, such as the labor force participation rate or the average annual wage of agricultural workers. The relationships in the consequence functions are based on results reported in the literature. All the consequence functions and the sources from which they are derived are summarized in Appendix 2. The consequence functions are numerous and varied, and although it is not our purpose here to review them all, it is useful to describe a few in order to see how they work.

Child Mortality Models

The PROFILES function linking weight-for-age to childhood deaths illustrates many features of the consequence functions. This function is based on a meta-analysis of eight studies from five countries (Bangladesh, India, Malawi, Tanzania, and Papua New Guinea), which reveals that in children aged 6 months to 5 years the risk of death increases exponentially as protein-energy malnutrition (as assessed by low weight-for-age) becomes more severe (Pelletier 1994; Pelletier et al. 1993, 1994). Even though malnutrition prevalence, morbidity patterns and mortality rates varied across countries, the same exponential relationship was observed, suggesting an underlying biological relationship between malnutrition and mortality. On the basis of these findings, the model assumes that children with mild, moderate and severe malnutrition face, respectively, 2.5, 4.6, and 8.4 times the risk of dying as children with no malnutrition. This function calculates the number of deaths in any year T as a function of nine independent variables: the population of children in year T (*Population*), the four weight-for-age prevalence variables in year T ($Prev_{1,T} \ldots Prev_{4,T}$), and the four mortality rates associated with the four weight-for-age categories ($MR_1 \ldots MR_4$), according to the following equation:

$$Deaths_T = Population_T \times \sum_{i=1}^{4} (Prev_{i,T} \times MR_i)$$

All the variables in this equation refer only to the U5 population, usually to the population of children aged 6 to 59 months or 1 to 59 months. PROFILES assumes that a mortality rate associated with a particular nutritional status is invariant over time for a particular country. This assumption allows us to estimate the rates in a base year and then apply the results to all future years for that country. The base year mortality rates associated with the four weight-for-age categories are estimated from base year data on the U5 population, mortality and nutritional status prevalence, and estimates from the literature of the relative risk of death in the four weight-for-age categories according to the population-attributable risk method as used by Pelletier (Pelletier et al. 1994). Table 1 illustrates these calculations in the Senegal application.

Table 1. Predicted Under-Age-5 (U5) Deaths for *No Change* and *Improved Nutrition* Scenarios—PROFILES Senegal Application

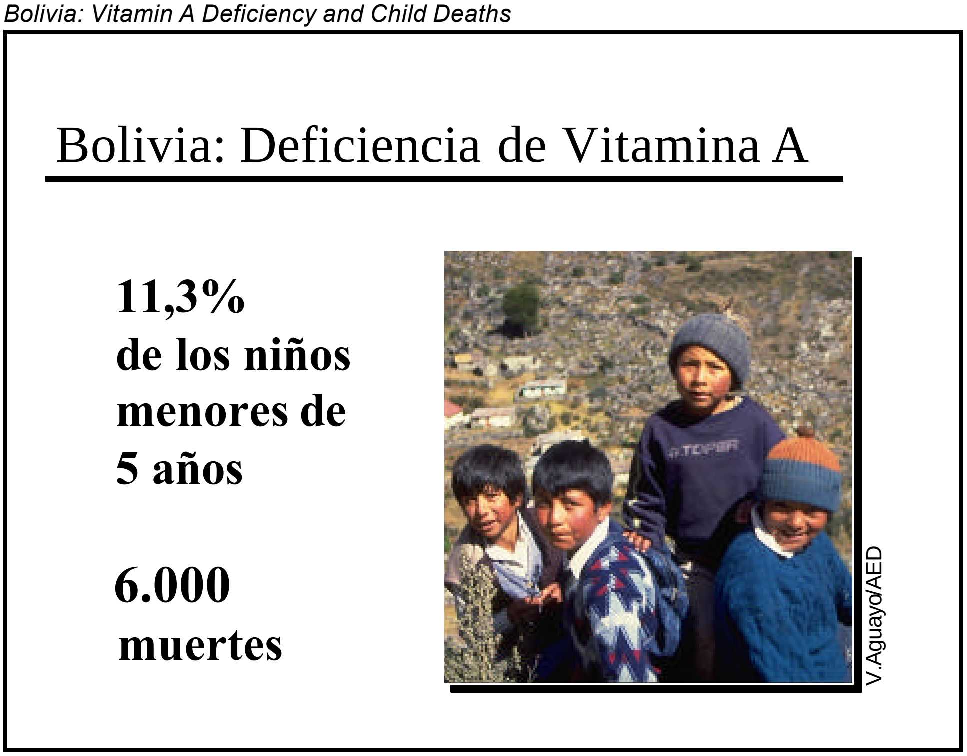
Scenario	Item	1995	1996	1997	1998	1999	2000	Total
	U5 population (thousands)	1,441	1,495	1,548	1,598	1,647	1,701	NA
A. *No Change* (Baseline)	Normal weight-for-age (%)	76.5	76.5	76.5	76.5	76.5	76.5	NA
	U5 deaths	29,131	28,671	28,621	28,479	28,225	28,336	171,463
	U5 mortality rate (deaths/1000 population)	20.2	19.2	18.5	17.8	17.1	16.7	NA
	Nutrition-related U5 deaths	10,070	9,911	9,894	9,845	9,757	9,795	59,272
B. *Improved Nutrition*	Normal weight-for-age (%)	76.5	77.8	79.2	80.5	81.9	83.2	NA
	U5 deaths	29,131	28,127	27,534	26,857	26,082	25,647	163,378
	Nutrition-related U5 deaths	10,070	9,367	8,807	8,223	7,614	7,106	51,187
	Lives saved over scenario A	0	544	1,087	1,622	2,143	2,689	8,805

Note: This table shows the year-by-year estimates of U5 deaths as a function of underweight prevalence for two different scenarios using the Population Attributable Risk procedure used by PROFILES in many of its consequence functions. Scenario A (No Change) serves as the baseline, while scenario B estimates the impact of a hypothesized nutrition improvement program that is assumed to reach the goals of the national nutrition action plan by reducing the prevalence of mild underweight by 30% and moderate and severe underweight by 25% each over six years in a linear fashion. Both scenarios (A and B) assume that the relative risk of death of underweight children follows Pelletier's results (2.5, 4.6, and 8.4 for mild, moderate, and severe underweight, respectively) for children of all ages through 72 months throughout the six-year period. Scenario A assumes that the total U5 population and total U5 deaths both equal the UN median projections and the prevalence of mild, moderate, and severe underweight in U5 children remain unchanged and equal to the 1993 DHS findings at 17.3%, 5.0%, and 1.2%, respectively throughout the six-year period. Mortality rates by nutritional status category are calculated for 1995 from the prevalence, relative risks, and total U5 mortality rate in that year, and they are adjusted in subsequent years in proportion to the change in U5 mortality rate for the year. The hypothesized program saves 8,085 lives over the six-year period.

In fact, evidence indicates that all six nutritional conditions influence child mortality. However, different combinations of indicators influence mortality at different ages: stillbirths are a function of birth weight and iodine status; neonatal mortality is a function of birth weight, iodine status, iron deficiency anemia (in pregnant women), and breastfeeding initiation; and mortality in children aged 1 to 59 months is a function of weight-for-age, feeding practices, and vitamin A status. For this reason, and because appropriate feeding practice changes at 6 months of age, four different functions are used to estimate deaths in the four different groups (stillbirths, neonatal, 1–5 months, and 6–59 months). Figure 5 was used in the Bolivia presentation to illustrate the impact of vitamin A deficiency on child mortality.

Unfortunately, the literature provides little guidance on the interactive effect of multiple simultaneous nutritional deficiencies on mortality. As a default strategy, PROFILES assumes that relative risks multiply and prevalences (or incidences) are independent, with the exception of three pairs of indicators that are assumed to be nonindependent (weight-for-age and vitamin A status, feeding mode and vitamin A status, and iron status during pregnancy and birth weight). Another exception is the effect of iodine status during pregnancy on stillbirths and neonatal mortality, which, on the basis of the findings of Clugston (Clugston et al. 1987), is assumed to be additive.

Figure 5.
Bolivia: Vitamin A Deficiency and Child Deaths



Note: This slide introduces the effect of vitamin A deficiency on child mortality in the Bolivian presentation. Vitamin A deficiency in 11.3 percent of Bolivian children produces 6,000 additional deaths per year. This result is based on a meta-analysis by Beaton et al. (1993) which concluded that

Model of the Economic Value of Breast Milk

This consequence function computes the volume and economic value of breast milk from the prevalence of different feeding practices. Estimates of the volume of breast milk produced in a country are based on information about the average daily volume of breast milk as a function of the child's age and feeding mode (full, partial, or no breastfeeding) and the prevalence of these feeding modes. The imputed market value of this breast milk is estimated by using the price per liter of the most common substitute for breast milk (cow's milk in rural areas and formula in urban areas). Values for urban and rural populations are calculated separately because of the large differences in feeding practices and in the type and price of breast milk substitutes in urban and rural areas.

Tables 2 and 3 show the step-by-step calculations of these functions for Bangladesh in 1990. This model is based on work by Alim (1993), Brown (Brown et al. 1982), Huffman (Huffman et al. 1991), and Levine and Huffman (1990).

Table 2. Estimated Volume of Breast Milk Produced in Bangladesh in 1990—PROFILES Bangladesh Application

		Age of Nursing Child (Months)					Total
		0–5	6–11	12–23	24–35	36–47	
1.	Average maximum potential daily production/mother (ml)	650	610	530	360	200	NA
2.	National population at this age in 1990 (millions)	2.4	2.3	4.4	4.3	4.2	17.6
3.	Potential total national annual production in 1990 (million liters) (row 1 × row 2 × 0.365)	570	512	851	565	307	2,805
4.	Less annual *rural* loss in million liters due to						
	a. Not breastfeeding at all	4.8	8.6	56.9	198.0	205.0	474.0
	b. Shortfall from partial breastfeeding	21.0	87.3	247.6	137.0	30.8	523.7
5.	Estimated national production of breast milk in 1990 (million liters)						
	a. Rural areas	450.7	332.1	406.9	136.9	20.6	1,347.2
	b. Urban areas	79.6	58.6	71.8	24.2	3.6	237.8
	Total (rural and urban)	530.3	390.7	478.7	161.1	24.2	1,585.0

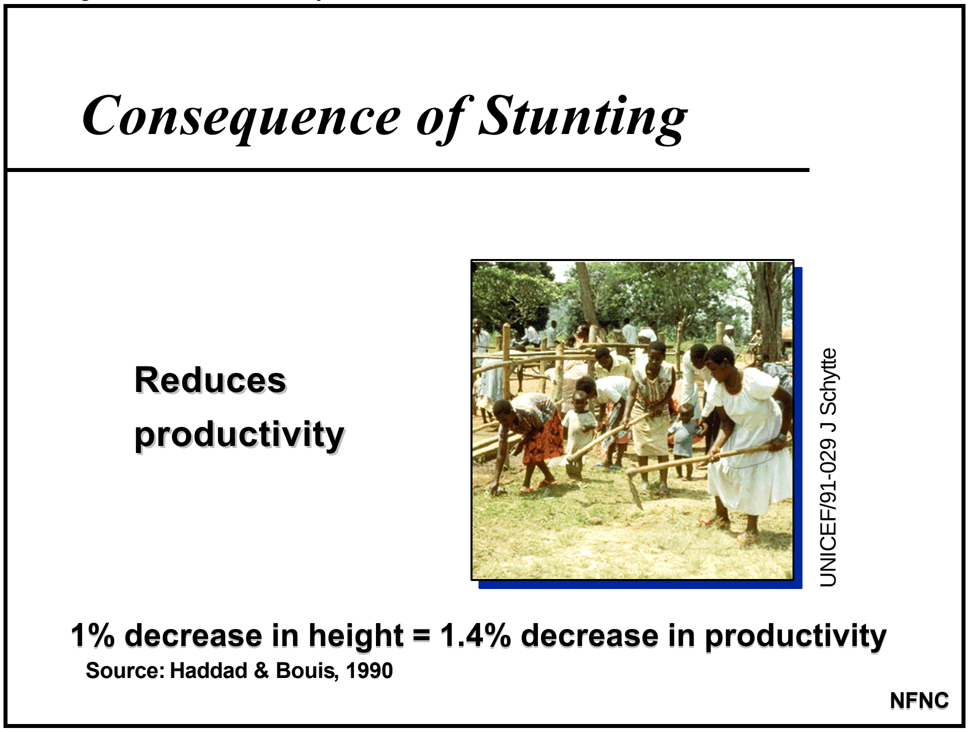
Note: The calculation in this table is adapted from Alim (1993) and incorporates data from Brown (Brown et al. 1982) and Huffman (Huffman et al. 1991). It illustrates the procedure used in PROFILES to estimate the annual national production of human milk in millions of liters. The calculation assumes that 83.6% of the population lives in rural areas and that the volume of breast milk produced by the average urban mother is 90% of that produced by rural mothers. For the five age categories, the prevalence of no breastfeeding in *rural* areas in 1990 is 1%, 2%, 8%, 42%, and 80% and of partial breastfeeding is 22%, 68%, 87%, 58% and 20%. The average shortfall from partial breastfeeding relative to the potential (row 1) by age category is assumed to be 20%, 30%, 40%, 50%, and 60%. The rural loss due to not breastfeeding (row 4a) = potential national production (row 3) times proportion rural (83.6%) times prevalence not breastfeeding. The rural loss due to partial breastfeeding (row 4b) = potential national production (row 3) times proportion rural (83.6%) times prevalence of partial breastfeeding times average shortfall from partial breastfeeding. Estimated rural production in 1990 (row 5a) equals row 3 minus (row 4a + 4b). Estimated urban production in 1990 (row 5b) equals (row 5a × 0.9 × 0.164/0.836). Line 4a contains rounding errors.

Table 3. Estimated Direct Cost of Breast Milk Substitutes in Urban and Rural Areas—PROFILES Bangladesh Application

Scenario	Item	1993	1994	1995	1996	1997	1998	1999	2000
	Urban population as % of total	18.3	18.9	19.5	20.2	20.9	21.5	22.2	22.9
A. *Current Trends Continue*	National production (million liters)	1,290	1,270	1,257	1,259	1,283	1,310	1,352	1,376
	Value of national production (million $)	431	426	424	427	437	451	466	476
B. *Improved Nutrition*	National production (million liters)	1,290	1,277	1,272	1,281	1,315	1,359	1,406	1,443
	Value of national production (million $)	431	431	435	443	461	483	506	526
Improved Nutrition minus *Current Trends Continue*	One-year difference in value (million $)	NA	5	11	16	24	32	40	50
	Cumulative difference (million $)	NA	5	16	32	56	88	128	178

Note: The calculation in this table attempts to answer the question: What would it be worth, in terms of the market value of breast milk, if urban mothers in Bangladesh had the same breastfeeding practices as rural mothers? To answer the question, two different scenarios are explored: in "Current Trends Continue," the volume of breast milk produced by the average urban mother is assumed to deteriorate linearly from 90% of the volume produced by the average rural mother in 1993 to 80% in the year 2000, whereas in "Improved Nutrition" the volume produced by the average urban mother is assumed to increase linearly from 90% of the volume produced by the average rural mother in 1993, when a hypothesized nutrition improvement program is assumed to start, to 100% in 2000. The comparison of urban and rural mothers assumes a similar age distribution of children. Each year the volume of breast milk produced in rural and in urban areas is estimated by using the procedure in Table 2. Breast milk is valued at the 1993 market price of its most frequent substitute, assumed to be cow's milk in rural areas (valued at $0.25 per liter) and powdered formula in urban areas (valued at $0.75 per liter). Under "Current Trends Continue," urban mothers account for 19% of the volume and 42% of the value of all breast milk produced nationally in 2000, while under "Improved Nutrition" urban mothers account for 23% of the volume and 47% of the value of all breast milk produced in 2000.

Figure 6.
Stunting Reduces Productivity



Note: This slide, used in Zambia and elsewhere, portrays the connection between stunting in childhood and reduced productivity during adulthood. In a seminal study in the Philippines, Haddad and Bouis (1990) found a linear relationship between physical stature and productivity of adult laborers, and in Guatemala, Rivera found that stunting in childhood from protein-energy malnutrition continued into adulthood, yielding adults of short stature (Rivera et al. 1995).

Worker Productivity Models

PROFILES contains several consequence models that relate nutritional conditions to worker productivity. In some, *future* productivity losses occur as a result of permanent damage due to nutritional insults early in life; in others, *current* productivity of adult workers is reduced by temporary effects of current malnutrition; in still others, productivity losses are due to the death of a potential worker. Examples of permanent damage in childhood that cause later losses in productivity include mental deficiencies due to iodine deficiency during pregnancy, vision impairment due to vitamin A deficiency, and stunting (see figure 6). Alternatively, iron deficiency anemia is an example of a nutritional condition that causes current productivity losses in adult workers.

Future productivity losses due to protein-energy malnutrition in early childhood illustrate many features of the worker productivity consequence models. Evidence for the relationship between protein-energy malnutrition and productivity comes from an extensive literature, reviewed recently by Martorell (1996), that spans several fields, including nutrition, physiology, economics, and history. In a controlled child feeding trial in Guatemala, children who received a high-protein, high-energy supplement had better growth than children who received a low-energy drink. They maintained this growth advantage throughout adolescence and young adulthood (Rivera et al. 1995) and performed better on physical capacity tests (Haas et al. 1995). The economic historian Robert Fogey received a Nobel Prize in 1993, partly for his work demonstrating that about 30 percent of the rise in productivity in Europe in the last two centuries was directly due to improvements in nutrition. The underlying mechanism for the relationship between nutrition and productivity is not well understood, but it may be due as much to effects on internal organ systems and physiological functions as to size alone, with height serving as a marker for the less visible effects.

The consistency of this evidence from diverse sources is convincing, but not enough rigorous studies that quantify this effect have been done to support a meta-analysis. One of the best studies was carried out in the Philippines, where the wages earned by sugarcane workers were higher by 1.38 percent for every 1 percent increase in their height (Haddad and Bois 1991). This finding was used in many of the applications of PROFILES to estimate potential labor productivity gains from reduced child stunting, including those in Zambia (see figures 6 and 7) and the Philippines (see table 4).

In Table 4, Haddad and Bouis's finding is applied only to adults who suffered moderate and severe stunting during childhood, although the finding is also applicable to mild stunting; the calculations assume that absolute height deficits in childhood (at 2 years of age) are maintained into adulthood, recognizing that although there may be limited potential for catch-up growth, in practice this rarely occurs. The future lifetime earnings of the stunted children are discounted back to the present, after adjusting for normal mortality, unemployment, and lower productivity.[3]

Figure 7.
Zambia per Child Productivity Estimation

Zambia Per Child Productivity Estimation

	Annual Productivity ($)		Years of Labor	Lifetime Productivity ($)
normal	336	x	50	= 16,800
stunted	314	x	50	= 15,700
				$ 1,100

NFNC

Note: This simple calculation compares lifetime productivity, as measured by wages, of stunted and normal individuals in Zambia based on the Haddad and Bouis (1990) study and the magnitude of the stunting in Zambian children. To simplify the presentation, this slide does not bother to discount future wages back to the present, although PROFILES does this before presenting final estimates. Potential productivity gains for the country as a whole also adjust for unemployment and age-specific survival probabilities.

Table 4. Five-Year Projection of Discounted Future Wages Lost because of Childhood Stunting—PROFILES Philippines Application

Scenario	Item	1994	1995	1996	1997	1998	1999	Total
	Population aged 2–2.9 (thousands)	1,885	1,878	1,817	1,836	1,850	1,862	NA
A. *No Stunting*	Present value at age 2 of lifetime wages (million $)	10,320	10,282	9,948	10,051	10,129	10,194	NA
B. *No Change* in nutritional status	% stunted at age 2 (mild + moderate + severe)	67.6	67.6	67.6	67.6	67.6	67.6	NA
	Present value at age 2 of future wages lost due to stunting (million $)	261	260	252	254	256	258	1,541
C. *Improved Nutrition* in moderate and severe stunting	% moderately stunted at age 2	25.4	22.9	20.3	17.8	15.2	12.7	NA
	% severely stunted at age 2	10.2	9.2	8.2	7.1	6.1	5.1	NA
	Present value at age 2 of future wages lost due to stunting (million $)	261	244	220	205	191	176	1,297
Gain of *Improved Nutrition* over *No Change*	Net gain in present value at age 2 of future lost wages (million $)	0	16	32	49	65	82	244

Note: The projections in this table illustrate the procedure used by PROFILES to estimate the present value of future productivity losses due to stunting in childhood. The figures are taken from the Philippines application of PROFILES. They show the estimated effect of reducing the prevalence of moderate and severe stunting by half, over a period of 5 years. The calculation in scenario A (no stunting) assumes an annual wage equal to that of the average agricultural worker in 1991 ($516), a 64.5% labor participation rate, and a lifetime discount factor of 16.45 that assumes a 3% annual discount rate, normal mortality, and labor force entry and exit at 15 and 64 years, all discounted back to the age of 2 years. In the "No Change" scenario, the prevalence of mild, moderate, and severe stunting at age 2 is assumed to be 32.0%, 25.4%, and 10.2% (summing to 67.6%) in all years, and the estimate discounted lifetime earning makes the same assumptions as in scenario A, plus the assumptions that mild, moderate, and severely stunted 2-year-olds have adult height deficits of 3.125%, 4.375%, and 6.25%, respectively; that the productivity elasticity with respect to height is 1.38; and that two-thirds of the jobs are agricultural or heavy manual labor to which the height-productivity relationship applies. In scenario C (Improved Nutrition), the prevalence of moderate and severe stunting are reduced by half, as shown, while mild stunting is unchanged at 32.0% for all years. The present values of future wages lost due to childhood stunting are calculated as in scenario B.

Implementing PROFILES

PROFILES is designed to be customized for each country and each application where it is to be used. This involves finding implementation partners, incorporating country-specific data in the models, and adapting the advocacy process. Most applications are best served by starting with a two- to three-week technical assistance visit to work with a local team to carry out the initial steps and transfer the PROFILES technology. The main steps to implementation include the following:

- Identify key parties in the country that are interested in taking the lead in the nutrition advocacy process and that will sponsor the PROFILES application. Such key parties have often been local offices of international donor organizations, such as UNICEF or USAID, or projects supported by one of these donor organizations such as BASICS, Linkages, or the Nutrition Communication Project, in addition to local governmental agencies.

- Key parties should agree on the purposes of the application and make clear the context and limitations. For example, the purpose might be to call high-level attention to the magnitude and importance of the nutritional problems facing the country or to scale up a small program by developing plans for the scaled-up version, estimating its cost effectiveness, and generating the needed financial and political support.

- Collect country-specific data on population, prevalence of various nutritional conditions, and other parameters required in the demographic and consequence models, and review scientific studies relevant to the application of the models in that country. Reach agreement about the scientific basis for the models and the calculations among national experts. If one of the objec-tives is to promote a particular program or programs, collect data on program costs, effective-ness, and anticipated coverage and reach an agreement with program experts on a description of the program in these terms.

- Identify a priority audience and frame preliminary arguments and processes to reach this audience.

- Use the PROFILES models to carry out a “sensitivity analysis” on the effect of key variables on projected consequences. This process can identify where additional data collection or consensus building is needed and which arguments are strongest from a scientific point of view.

- If necessary, modify existing models or develop new ones to capture the strongest arguments.

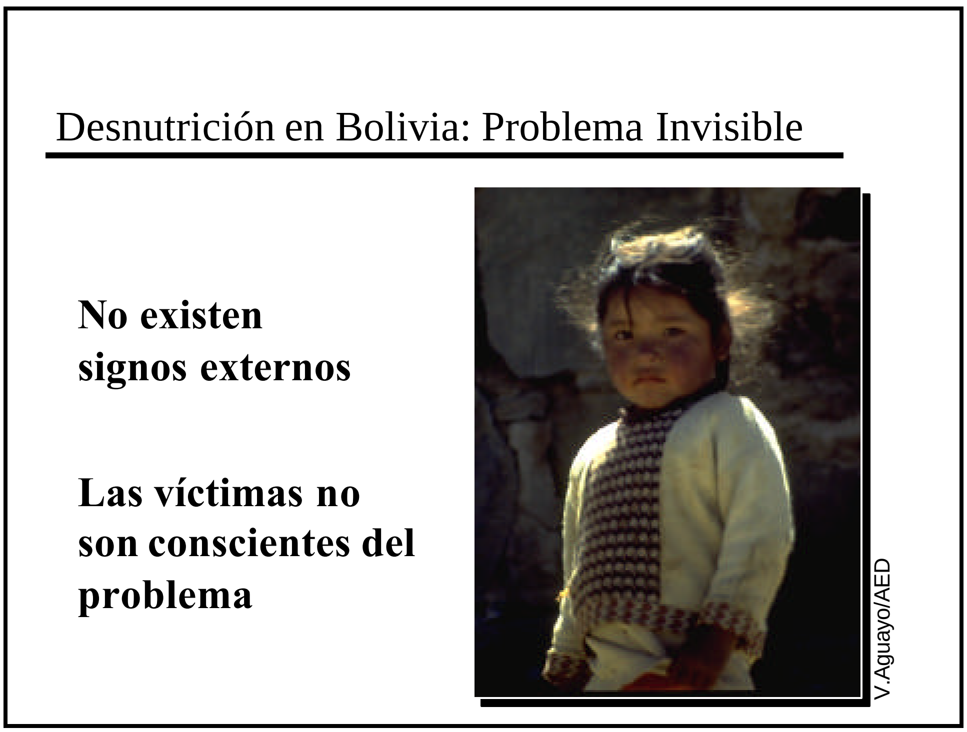
- Prepare basic scripts and associated visual displays to make persuasive oral presentations aimed at particular audiences in particular settings. This step includes the use of software programs, such as commercial spreadsheets, commercial graphics presentation software, or the PROFILES Pascal programs, as well as a review by communication experts for introducing photographs and other visual materials that will add emotive appeal (see figures 1, 8, 9, and 12).

- Test the presentations using trial runs to check for internal coherence and for correspondence of the script and models with reality.

- Prepare handouts for the audience, including copies of the script, printouts of the screens, and documents detailing the scientific basis for the arguments presented.

- In addition, most applications include a technology transfer objective. The participatory consensus-building process that involves local institutions and individuals at every step of the application is the primary way that this objective is achieved. Training sessions on the structure and use of the models and computer programs, and the creation and delivery of full documentation, also contribute to this objective.

Figure 8.
Malnutrition Can Be an Invisible Problem



Note: This slide, which introduces the micronutrient section in the Bolivia presentation, uses a photo with emotional appeal.

Applications

PROFILES has been used in more than a dozen developing countries. The initial applications were in Bangladesh and then the Philippines, with financial and technical support from UNICEF, USAID, the World Bank, and the Asian Development Bank, in collaboration with national ministries and nutrition institutes. This led to additional applications in Asian countries as part of an effort by UNICEF and the Asian Development Bank to promote early child development. Next, the application of PROFILES in several African countries was promoted by BASICS, working in cooperation with the USAID-supported Linkages and SARA projects, UNICEF, and numerous national and regional institutes and ministries. Applications for Ghana, Mali, Senegal, Uganda, and Zambia produced a French version of PROFILES materials and presentations, simplified the computer software, and expanded the planning process. Finally, Latin America became a participant, with a recent application in Bolivia that yielded a Spanish version.

In some applications, PROFILES focused on analyzing and promoting particular interventions already partway along in the design process. In other cases, it was used to increase awareness among decision makers of the need for greater investment in nutrition, while in still others it served as a convenient mechanism for forming an interagency planning team and defining a planning process.

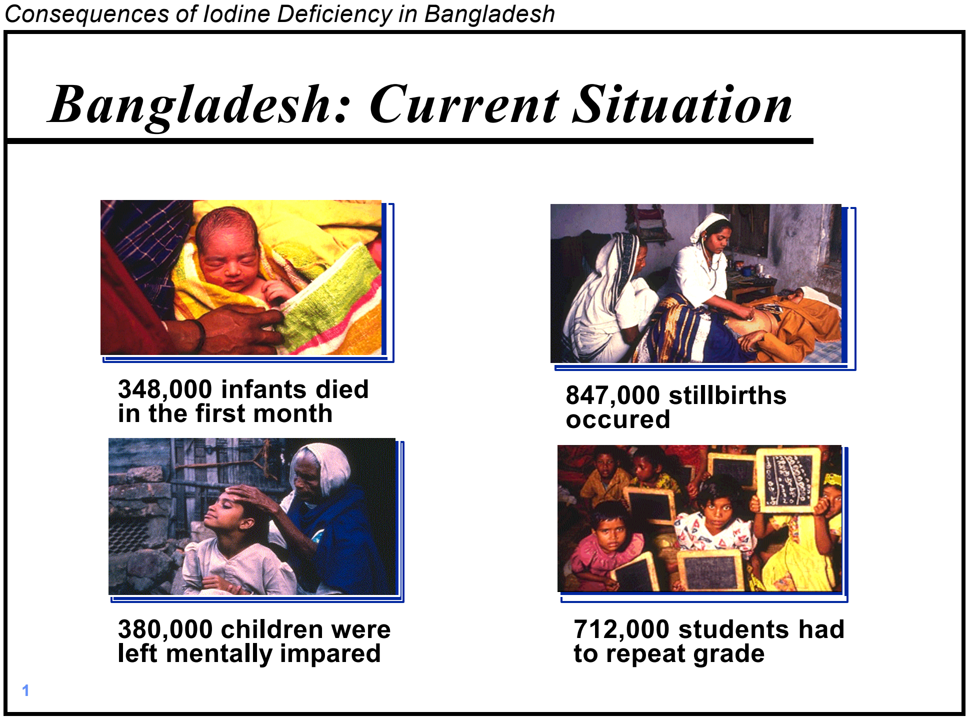
Bangladesh Application

Although the nutrition problems facing Bangladesh in the early 1990s were daunting (e.g., 70–90 percent prevalence of protein-energy malnutrition in children, 65 percent prevalence of iron deficiency anemia, 47 percent goiter prevalence, 40 percent low birth weight), the country was preoccupied with many equally challenging difficulties. In response, the Ministry of Health, UNICEF, and the World Bank undertook a policy development and advocacy process to raise nutrition to national priority, incorpor-ating PROFILES in that process. Initially, in 1992–1993, PROFILES was used to call attention to the enormous nutrition problems confronting the country but without examining specific programmatic strategies. Then, in 1993–1994, after attention was gained, focus shifted to specific action programs, most notably a community-based young child nutrition program and a salt iodization program.

Local scientists, planners, and program managers were involved in adapting the PROFILES models to Bangladesh. First, Bangladesh data and studies were reviewed and adapted to the PROFILES consequence and demographic models. Base year (1990) nutritional prevalence and parameters in the consequence functions were estimated from published and unpublished sources in the international and local literature (Burkhalter 1993a; Burkhalter et al. 1994). Approximately 20 Bangladesh scientists and planners reviewed and modified the data and consequence models for the general advocacy effort during a two-day workshop. Later, many of the same individuals met to develop intervention models for specific programs. To create a presentation that would be brief yet powerful enough to persuade high-level officials, representatives from the Ministry of Health and UNICEF reviewed all the consequence models and picked four for inclusion in a 20-minute presentation: (1) child deaths averted by reducing weight-for-age under-nutrition in preschool children, (2) fewer births of cretins and low-IQ children by eliminating iodine deficiency in pregnant women, (3) increased breastfeeding in urban areas and the resulting monetary savings from reduced use of substitutes (see tables 2 and 3), and (4) increased productivity of agricultural workers from decreased iron deficiency anemia. The magnitude of potential payoffs over a seven-year period impressed many audiences—over 1 million child deaths averted, 630,000 fewer mentally deficient individuals, $178 million saved from increased urban breastfeeding, and a potential productivity increase in agricultural workers of nearly $3 billion. In one week, the results were crafted into a script and graphics presentation by the project team, using publications that had been well received in Bangladesh as guides for framing the argument (Huq 1991; UNICEF 1992a). The script was first presented to a meeting of the Bangladesh Permanent Secretaries in January 1993. The 20-minute presen-tation was followed by a spirited open discussion. According to UNICEF representatives, this presenta-tion was repeated to various audiences more than 60 times over the next three months, generating wide-spread awareness of the need for nutritional investments.

While the first PROFILES presentation was used to build a favorable climate for solving nutrition problems in Bangladesh, subsequent presentations focused on three specific nutrition problems and programs to address them: salt iodization, young child malnutrition, and iron supplementation and fortification. The presentation on salt iodization supported the launch of a new program by the gov-

Figure 9.
Consequences of Iodine Deficiency in Bangladesh



ernment and UNICEF.

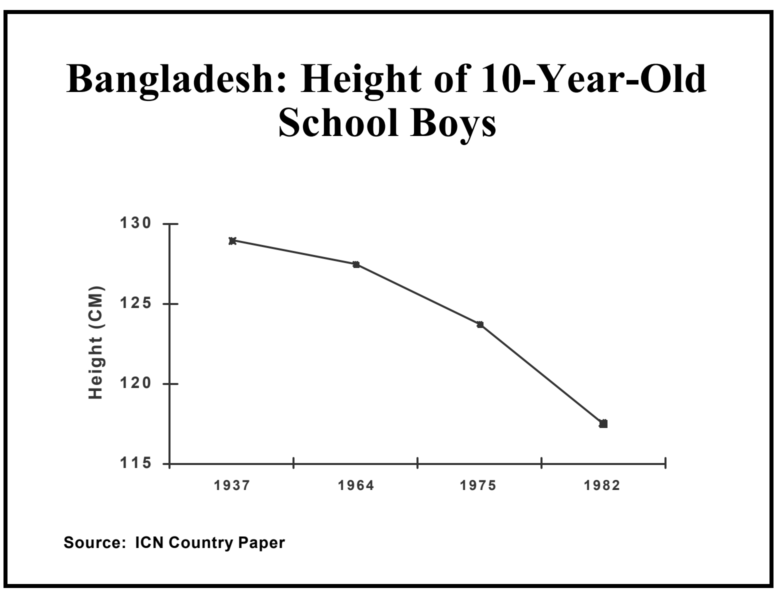
Note: This summary of the consequences of iodine deficiency in Bangladesh is based on a meta-analysis by Clugston et al. (1987), which concludes that iodine deficiency during pregnancy produces about 65 additional late miscarriages, stillbirths, and neonatal deaths per 1,000 live births in iodine deficient communities, and a controlled intervention study in Ecuador by Fierro-Benitez (Fierro-Benitez et al. 1986), which found that many fewer students had to repeat a grade in communities where iodine deficiency was eliminated. The calculations assume a national prevalence of iodine deficiency equal to 10.5 percent, It emphasized the importance of investing in enforcement, packaging, and public education as a complement to salt iodization that would speed widespread coverage and high effectiveness. The breadth and magnitude of the problems caused by iodine deficiency in Bangladesh justified significant investments and caught the attention of many high-level decision makers (see figure 9).

The selection of the base year goiter rate was an interesting issue. A 1982 survey reported a 10.5 percent national goiter rate (the estimate used in the first PROFILES application), but the 1993 National Goiter Survey reported a surprisingly high national goiter rate of 47 percent. This 4.5-fold increase in 11 years seemed implausible to many, but the careful methodology used in the 1993 survey finally convinced the Bangladesh scientific community, which agreed to stand behind the higher figure, thereby providing persuasive support for national action to correct the problem. The Ministry of Health and UNICEF had developed detailed plans for the salt iodization program over several years, and these plans provided the basis for estimating PROFILES values for costs, coverage, and effectiveness.

The presentation on young child nutrition described the Bangladesh Integrated Nutrition Project, designed by the Ministry of Health and the World Bank as a programmatic response to the multiple health and nutrition problems facing the children of Bangladesh.[4] This 15-minute presentation stressed the economic payoffs and design features of the program. It hit hard at the deteriorating nutritional status in Bangladesh with several attention-getting graphs (see figure 10). The salt iodization and young child malnutrition presentations were given to many audiences. World Bank officials credited the PROFILES application with a crucial role in gaining the government's acceptance of the young child nutrition program and obtaining approval of an associated World Bank loan in May 1995.

The presentation on iron supplementation and fortification modeled two programs aimed at alleviating iron deficiency anemia: (1) an iron supplementation program and (2) a salt double fortification program (with iron and iodine). Both stressed benefits to pregnant women and newborns, as well as productivity increases among laborers.

Figure 10.
Decline in Average Height of 10-Year-Old School Boys in Bangladesh



Philippines Application

In the Philippines, the PROFILES application helped develop and advocate a proposed early childhood development program that included a large nutrition component in combination with health, family planning, and education components. In 1994–1995, to integrate analysis, planning, and advocacy into one process at an early stage of program planning, the Philippines Department of Health, the National Nutrition Council, and the Asian Development Bank introduced PROFILES.

Published and unpublished sources in the international literature and the Philippines provided data for the demographic and consequence models (Acuin et al. 1989; Cabigon 1992; Florencio 1987; FNRI 1991, 1994; Govt. of Philippines 1993; Haddad and Bois 1991; Popkin et al. 1990; Tupasi et al. 1990; UNICEF 1992b). Philippine scientists and other professionals reviewed the results. Estimates of costs, coverage, and effectiveness for the early childhood development program were obtained from planning documents that had been jointly prepared by the Asian Development Bank, World Bank, and the Philippines Department of Health. Several consequence functions were developed in greater depth for the Philippines application. The assumptions and data used were carefully documented (Ross 1995; Zerfas 1995).

Three script and slide show presentations (7, 15, and 30 minutes each) were prepared for people at different levels of influence. The shorter versions, containing less technical information, were directed at higher-level decision makers, who could then ask their staff to scrutinize the technical documentation. The presentations emphasized both the increased productivity benefits of the program (see figure 13 in Discussion and Lessons Learned) and the elements required for the program to work (see figure 11).

The seven-minute version made two important economic arguments: (1) the current generation of Philippine children must be adequately nourished from conception to enable the future Philippine workforce to function at its full physical and intellectual potential to compete effectively with its newly

Figure 11.
Phillippines: Poor Weaning Diets

Note: This slide from one of the Philippines presentations addresses some characteristics needed for a successful program.

industrialized neighbors, and (2) the proposed nutrition program should be seen as an investment opportunity that will pay for itself by the increased economic productivity of the Philippine workforce.

Ghana Application

In the Ghana application, as in most PROFILES applications in Africa, the focus has been on raising awareness about nutrition problems and their importance to the future of the country rather than obtaining political and financial support for particular projects. The application process was undertaken by the Nutrition Unit of the Ministry of Health, the Centre for Social Policy Studies at the University of Ghana, and UNICEF. It involved a small core group of technical experts who worked intensively on policy analysis and communications tools, and a larger group of technical advisors from higher decision making levels, who guided the core group. Both groups included nutrition and health professionals from a variety of government ministries, universities, and nongovernmental agencies. Two nutritional epide-miologists with PROFILES experience facilitated a two-week workshop in September 1997, beginning with a two-day meeting of both groups to set priorities and agree on a process. The core group did the detailed hands-on work with the models, wrote a script, and prepared the computer presentation; the larger group provided guidance on overall strategy, priority objectives, and target audiences.

The demographic and consequence models, programmed in commercial spreadsheet software, estimate costs and potential benefits of reaching year 2001 targets for reduced malnutrition as specified in the Ghana National Plan of Action for Nutrition or, where the national plan specified no target, as established by the combined core and advisory group. The models focus on mortality, lost productivity, and the health and fertility benefits of breastfeeding.

At the time of the PROFILES application, Ghana had recently announced its “Vision 2020” initiative to become a middle-income country by the year 2020. The PROFILES presentation uses this theme, pointing out that the children currently being conceived and born will enter the workforce in the year 2020. It argues that the hope of becoming a middle-income country depends on nutrition investments now in order to ensure the survival, educability, and productive capacity of these children. The advocacy event on the final day of the workshop was attended by about 40 decision makers from a broad cross-section of government and donor agencies, many of whom committed their agencies to support specific activities after the presentation. Since this success, the core group has remained active, modifying and using the presentation with different audiences. An immediate result, at least partly attributable to the PROFILES advocacy, is that the new child survival strategy developed by the Ministry of Health during the month following the first PROFILES presentation made improved child nutrition its top priority, specifically citing the PROFILES presentation in its situation analysis.

Other Applications in Africa, Asia, and Latin America

In Africa, application of PROFILES began in Senegal and Uganda in 1995, in Zambia in 1996, and in Mali in 1997. In Uganda, the World Bank is using PROFILES to support the nutrition component of an early childhood development program. A PROFILES cost-benefit analysis quantified the gains in economic productivity that could result from reductions in iodine deficiency, maternal anemia, and child stunting. In Senegal, a PROFILES application is being undertaken by USAID and the Senegal Ministry of Health to increase awareness of nutrition problems and to foster cooperation among a variety of agencies for developing nutrition programs to address those problems. This application required the translation of the PROFILES software into French.

Figure 12.
Mali: Sustainable Development

In Zambia, PROFILES was used by the National Food and Nutrition Commission, a government body that has responsibility for policy making, planning, and advocacy in the nutrition sector. Using the

core/advisory group process, the application resulted in the development of a presentation that is being used among donor and government decision makers to raise awareness of nutrition problems at the national level. At this stage, it is too early to gauge results. Unfortunately, the core group consisted of only two nutritionists, and the input of the advisory group was too limited to permit significant ownership of the process. The application in Zambia will probably require further development to increase the involvement of more nutritionists and health professionals.

In Mali, PROFILES was applied in response to a suddenly increased awareness of malnutrition as a national problem, resulting from the release in 1997 of the results of the 1996 Demographic and Health Survey (DHS). These results indicated a sharp increase in the prevalence of underweight and stunting since the previous DHS survey in 1987–1988. The application began with a one-week visit to Mali by three nutritional epidemiologists with PROFILES experience, who described to a broad cross-section of nutrition and health professionals how the PROFILES process could contribute to various stages of the nutrition improvement process in Mali, from policy analysis through the identification and promotion of particular interventions. This de facto advisory group identified a core group of analysts and agreed on a schedule and process for the application of PROFILES. A group of four Malian analysts had been chosen earlier to travel to the Unites States to conduct an in-depth analysis of the new DHS data, a process in which the PROFILES trainers also became involved.

This was followed, within a month, by a two-week PROFILES workshop in Mali to further the policy analysis and develop a computer-based presentation. The workshop culminated with a formal presentation to an invited audience of decision makers. Future steps in this process will include the development of a 10-year nutrition investment plan. In this case, PROFILES analysis and advocacy is By interpreting nutrition prevalence data in terms that decision makers understand, such as illness, disability, and death, and by presenting this information in an effective way (see figure 12), PROFILES is fulfilling a key role in this process in Mali, moving quickly from data to decision making.

The Asian Development Bank and UNICEF have also used a variant of the PROFILES process in a regional project involving seven Asian countries.[5] The PROFILES analysis was one element in the development of national investment plans for nutrition. Five consultants, one of them a nutritional epidemiologist with PROFILES experience, were contracted to support the countries in the development of these plans. Because of resource constraints and the particular objectives of this regional initiative, it was decided to used a more streamlined approach than that used elsewhere. The PROFILES consultant developed spreadsheet models for each country, using a common time period (1997–2005) and a common set of consequences, and loaded these with demographic data derived from UN projections.

The spreadsheet models and a user's guide were distributed by e-mail to the country-level analysts, who then performed their own analyses. The "communications tool" in this case was not a computer-based presentation but a section in a national investment plan for nutrition prepared by each country according to a common format. These investment plans will be presented at a regional donor roundtable, thus serving as the basis for a regional investment plan for nutrition.

The recent application of PROFILES in Bolivia is the first in a Latin American or Spanish-speaking country. The application was carried out by the Linkages project, in collaboration with the Ministry of Health Nutrition Unit and major nutrition-oriented nongovernmental organizations, to help the Ministry meet new policy communication needs created by the government's decentralization process. PROFILES became the focal point for conducting policy analysis and developing a policy communications strategy to advocate a bold new investment in nutrition at the regional and municipal levels. To bring this about, distinctive models were developed for the three ecological zones of the country; these models were used to engage local leaders in nutrition policy dialogues most relevant to their area. UNICEF has requested that the communication strategy thus developed be used to advocate the adoption of a National Nutrition Policy with goals for the year 2002. This application is in Spanish.

PROFILES presentations have been used in a variety of other settings. The Bangladesh iodine presentation, Iodized Salt Plus, was given to the 1993 meeting of UNICEF country representatives in support of the global salt iodization program mounted by UNICEF, the Bangladesh PROFILES applications were incorporated into graduate nutrition courses at Emory University and The Johns Hopkins University, and the software has been used in graduate nutrition courses at Tufts University and the University of Indonesia. Portions of the Bangladesh young child malnutrition presentation were shown to the U.S. House of Representatives Subcommittee on Foreign Agriculture in support of fortification of donated food (House Subcommittee 1994).

Discussion and Lessons Learned

PROFILES has been applied in more than a dozen developing countries. It has been used to increase decision makers' awareness of the need for greater investment in nutrition, to facilitate the design and selection of programs, and to promote particular interventions in the early stages of the design process. Some notable successes have resulted. In Bangladesh, it played a crucial role in convincing the government to continue with a much needed $60 million community nutrition project financed by a World Bank loan; in the Philippines, its early success led to the incorporation of PROFILES into a joint Asian Development Bank–UNICEF initiative to promote early child development activities in seven Asian countries; and in Ghana, it moved nutrition to a top priority in the new national child survival strategy.

The application of PROFILES in a country involves several steps: (1) emergence of one or more organizations to champion the application; (2) reaching consensus on the purpose of the application and clarification of its context and limitations; (3) adapting and implementing a model, including obtaining and incorporating data; (4) developing presentations based on the model estimates around particular problems and programs; and finally (5) giving the presentations and engaging in associated dialogue with different audiences.

Experience to date indicates that three conditions are required for a PROFILES application to be successful: (1) the models and associated data must rest on sound research that is credible to the local scientific community and policy makers, (2) the magnitude of estimated improvements must be large enough to attract attention and justify the proposed investments, and (3) the advocacy process must be led by strong individuals and institutions who can generate and sustain the advocacy process at the highest levels for at least two to three years, with substantial involvement by the scientific and professional community.

The issue of credibility has been addressed differently by previous computer-based policy development tools reported in the literature. Grosse and Tilden (1988) relied on carefully supported estimates of model parameters to calculate the cost-effectiveness of different vitamin A interventions. Similarly, Mosley and Becker (1991) and Becker and Black (1996) used careful estimates of incidence and case fatality rates in combination with a frailty index that was largely a function of nutritional status to predict the impact of child survival interventions, but they noted the need to test the accuracy of predictions made by their model. An early nutrition and food simulation developed for the Food and Agricultural Organization by R. D. Duke and colleagues at the University of Michigan (Lorstad 1976) was embedded in a gaming simulation that generated motivation and general understanding of the long-term factors influencing food availability and nutritional status. It relied heavily on the involvement of the participants rather than on the validity of its predictions to achieve credibility. PROFILES uses both strategies employed by these previous efforts to achieve credibility for its predictions—careful estimates of model parameters and intensive involvement of local country experts.

There is variation in the strength and generality of the research results that support the different models in PROFILES and, as a result, in the reaction of local scientists to the different models. To discuss this variation, it is convenient to organize the models and their components into the following four groups.

Population model. The U.N. population model, with its low, medium, and high variants, is the best validated of the four component groups. It has been well accepted in the applications.

Definitions and base year values of the nutrition indicators. Many base year estimates of the nutrition indicators are based on representative national surveys and, as such, are usually of high quality and well accepted. However, incidence of low birth weight is a notable exception because population-based data have not been available. The base year estimates often generate the greatest discussion among local experts. A case in point is the discussion generated by the early surprising results of the Bangladesh 1993 goiter survey in which the national prevalence of goiter was reported to be 47 percent, up from an estimated 10.5 percent in the 1982 survey (Ahmad and Hassan 1982). The solid methodology used in the 1993 survey was the key to the eventual acceptance of the 1993 results.

Consequence models. The consequence models are largely independent of one another. Therefore, the validity of the different models can be addressed separately. The consequence functions establish three levels of assumptions: whether or not a particular nutritional indicator is causally linked to a particular consequence, the nature of that relationship, and the default values of the parameters in the relationship. The strength of the scientific evidence supporting these assumptions varies widely. At one extreme are results based on comprehensive reviews and meta-analyses of controlled interventions, and at the other end are models based on anecdotal evidence. Several functions rely on associations established in observational studies. An important example is the model linking weight-for-age to mortality in children. Although the meta-analysis by Pelletier and colleagues (Pelletier 1994; Pelletier et al. 1993, 1994) is careful not to claim a causal link between weight-for-age status and mortality, Schroeder and Brown (1994) and Pelletier (1994) make a strong case that the data and results reported in the meta-analysis meet the usual requirements necessary for causality (for example, consistent correlation, dosage effect, plausible biological explanation).

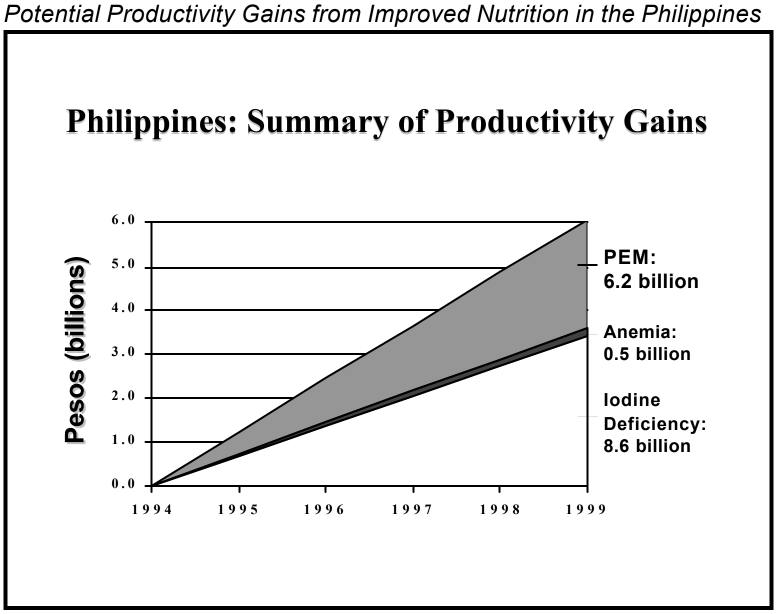
Program description. Program description has the weakest record in terms of supporting scientific evidence and validity. Cost estimates have been based on planned line item budgets, where the individual line items are well researched, but assumptions about change in costs over time (usually growth) and the connection of costs to growth in coverage and effectiveness have had minimal supporting scientific evidence.

The impact of improved nutrition on labor productivity has been an important selling point to policy makers outside the health field. Figure 13 summarizes the economic value of improved nutrition in the Philippines, as presented to decision makers in that country. Improved intellectual capacity and school performance has also been persuasive. Reductions in infant and child deaths provide a solid argument in favor of improved nutrition but attract less attention because they are expected by many audiences.

The need for estimates that are both credible and large enough to justify investments reflects the tension between the political and technical aspects of advocacy. The *political* aspect is related to the interests of different stakeholders, their relationships with each other, and their relative positions of power in making decisions, while the *technical* aspect is related to the provision of knowledge and resources needed to recognize and solve a problem. The software component of PROFILES is designed only to address the technical issues in the advocacy process, but the larger advocacy process of which PROFILES is a part gives more attention to political aspects. Sound analysis and strong technical arguments are ineffective if they are not presented in a way that makes sense to decision makers and offers them clear alternatives with political as well as technical benefits.

One benefit of PROFILES is that it may cause local planners to recognize weaknesses in program plans more clearly and obtain better information to make more accurate predictions of costs, coverage, and effectiveness. In the most successful applications of PROFILES, the technical nutrition communities helped provide the data, scrutinize the models and coefficients, formulate the arguments, and design the computer presentations as part of a participatory consensus-building process. This level of participation ensured that the arguments were based on the best science and data available and that a cadre of

Figure 13.
Potential Productivity Gains from Improved Nutrition in the Philippines



Note: Taken from the PROFILES presentation entitled “Fueling the Economic Dragon,” this graph shows the cumulative potential productivity increases estimated over 5 years by implementing an Early Childhood Development Program in the Philippines. The calculations assume a 50 percent reduction in moderate and severe stunting, total elimination of iodine deficiency, and 20 percent reduction of iron deficiency anemia. The reason that the productivity gain from reducing anemia is low relative to stunting and iodine deficiency is that the anemia reduction component of the program affects only current wages of pregnant and lactating women who are in the workforce, whereas the gains from reducing stunting and iodine deficiency, which produce permanent nutritional disabilities, include discounted lifetime wages of all children affected. An exchange rate of 28 Philippine pesos to U.S.$1.00 was used.

scientists able to defend these arguments were committed to the advocacy process. Participation thus strengthened both the technical and the political aspects of the advocacy efforts.

Appendices

Appendix 1. Nutrition Indicators and Variables in PROFILES

Appendix 2. Consequence Models in PROFILES

Appendix 1. Nutrition Indicators and Variables in PROFILES

Nutrition Indicator	Variable	Default Definition
Protein-energy malnutrition		
Weight-for-age (WA), 0-4 yr.	Prevalence of *normal* WA children Prevalence of *mild* WA children Prevalence of *moderate* WA children Prevalence of *severe* WA children	80% + of NCHS median 70–79% of NCHS median 60–69% of NCHS median <60% of NCHS median
Height-for-age (HA), 2 yr.	Prevalence of *normal* HA children Prevalence of *mild* HA children Prevalence of *moderate* HA children Prevalence of *severe* HA children	1 SD below NCHS median. 1–1.9 SD below NCHS median 2–2.9 SD below NCHS median 3+ SD below NCHS median
Birth weight	Incidence of *normal* weight births Incidence of *low* weight births	2500+ g <2500 g
Vitamin A		
Vitamin A status, 6–59 mo.	Prevalence of *normal* serum retinol (SR) status Prevalence of *low* serum retinol (SR) status	SR 20+ µg/dl SR <20 µg/dl
Night blindness, 0–14 yr.	Prevalence of *no* night blindness Prevalence of *night* blindness	
Iodine		
Iodine status, human population	Prevalence of *no* goiter Prevalence of goiter	*Without* palpable goiter *With* palpable goiter
Iodine status, livestock	Prevalence of *normal* iodine status Prevalence of *low* iodine status	
Iron		
Iron deficiency anemia status (IRON), by age and sex (0–4 yr., 5–14 yr., women 15–49 yr., men 15–49 yr., pregnant women)	Prevalence with *normal* hemoglobin Prevalence with *low* hemoglobin	Hemoglobin low threshhold: <11 for 0–4 yr. and pregnant women <12 for 5–14 yr. and women 15–49 yr. <13 for men 15–49 yr.
Feeding		
Feeding mode (FM), by age (0–5 mo., 6–11 mo., 12–23 mo., 24–36 mo., 36–47 mo.)	Prevalence of *full* breastfeeding Prevalence of *partial* breastfeeding Prevalence of *no* breastfeeding	
Initiation of breastfeeding	Incidence, *initiate* breastfeeding Incidence, *not initiate* breastfeeding	Per live birth Per live birth
Duration of breastfeeding	Average duration of breastfeeding	Any breastfeeding in months

Appendix 2. Consequence Models in PROFILES

Consequence (Dependent Variable)	Nutrition Indicators (Independent Variables)	Estimation Approach	Key Sources
1. Child mortality			
Stillbirths and neonatal deaths	BW, IOD (women 15–49 yr.), IRON (pregnant women), Initiate BF	PAR (BW, IRON, BF) Excess deaths (IOD)	(Burkhalter 1993b, Clugston et al. 1987, Mardones 1991, McCormick 1985, Murphy et al. 1986, Newman 1993)
Deaths (1–59 mo.)	FM, VA (6–59 mo.), WA	PAR	(Beaton et al. 1993, Bloem et al. 1995, Briend et al. 1988, Cunningham 1991, Huffman et al. 1991, Humphrey et al. 1992, Newman 1993, Pelletier 1994, Pelletier et al. 1993, Fauveau et al. 1990, Schroeder and Brown 1994, Stoltzfus et al. 1993, Victora et al. 1987)
2. Child morbidity			
Diarrhea days (neonatal)	BW, IRON (pregnant women), Initiate BF	PAR	(Acuin et al. 1989, Angeles et al. 1993, Black et al. 1984, Brown et al. 1989, Chowdhury et al. 1990, Feachem and Koblinsky 1984, Popkin et al. 1990)
Diarrhea days (1–59 mo.)	FM (1–11 mo.), WA	PAR	(Acuin et al. 1989, Black et al. 1984, Brown et al. 1989, Chowdhury et al. 1990, Feachem and Koblinsky 1984, Newman 1993, Popkin et al. 1990)
Respiratory infection days (neonatal)	BW, IRON (pregnant women), Initiate BF	PAR	(Angeles et al. 1993, Brown et al. 1989, Tupasi et al. 1990)
Respiratory infection days (1–59 mo.)	FM (1–11 mo.)	PAR	(Brown et al. 1989, Tupasi et al. 1990)
3. Maternal mortality			
Maternal deaths	IRON (pregnant women)	PAR	(Ross and Thomas 1996)
4. Fertility			
Total fertility rate (TFR)	BF duration, FM	Factor model	(Bongaarts 1978, Cleland et al. 1984, Habicht et al. 1985, Saadeh and Benbouzid 1990)
5. Vision			
New cases of complete and partial blindness (0–14 yr.)	NB (0–14 yr.)	Fraction of NB who go blind and partially blind	(Sommer 1990)

Prevalence of complete and partial blindness	NB (0–14 yr.)	Survival of new cases	(Sommer 1990, Levin et al. 1993)

Appendix 2. (continued)

Consequence (Dependent Variable)	Nutrition Indicators (Independent Variables)	Estimation Approach	Key Sources
6. Intelligence			
Cretin births	IOD (women 15–49 yr.)		(Clugston et al. 1987)
Mentally impaired births	IOD (women 15–49 yr.)		(Clugston et al. 1987)
Lost IQ points	IOD (women 15–49 yr.)		(Boyages et al. 1989, Bleichrodt and Born 1994)
7. School performance			
Repeaters grade 1	IOD (women 15–49 yr.), WA (6 yr.)	Relative risk model; WA interactive with tutoring	(Fierro-Benitez et al. 1986, Pollitt 1990, Florencio 1987)
Repeaters grades 2–6	IOD (women 15–49 yr.), WA (7–11 yr.)		
8. Government health and education expenditures			
Cost to treat diarrhea, respiratory infection and malnutrition	Diarrhea days {BW, FM, IRON, Initiate BF, WA}, Respiratory Infec days {BW, FM, IRON, Initiate BF}, VA, WA (severe+moderate)	Cost per outpatient visit plus hospital stays; VA affects severity, not duration of illness	(Ghana VAST Team 1993, Horton and Klaxon 1983, Lehman et al. 1985, Stanton and Clemens 1989)
Marginal cost to care for visually impaired children	Prevalence of complete and partial blindness 0–5 yr. {NB}		
Cost of deliveries	Total fertility rate {BF duration, FM}		
Cost of stillbirths and child deaths	Stillbirths + neonatal deaths {BW, IOD, IRON, Initiate BF}, Child deaths 1–59 mo. {FM, VA, WA}		
Antenatal and child health care costs for children who die and are replaced	Stillbirths + neonatal deaths {BW, IOD, IRON, Initiate BF}, Child deaths 1–59 mo. {FM, VA, WA}		(Horton and Klaxon 1983, Lehman et al. 1985, Stanton and Clemens 1989, UN Secretariat 1988)
Cost of school repeaters	Repeaters, grades 1–6 {HA, IOD}	Average cost of school for one-child-year	(Fierro-Benitez et al. 1986)
9. Volume and value of breastmilk			
Breastmilk volume produced	FM	Average production per woman by mode	(Alim 1993, Brown et al. 1982, Levine and Huffman 1990)
Monetary value of breastmilk produced	Breastmilk volume {FM}	Value of urban and rural substitutes	(Alim 1993, Oshaug and Botten 1994, Levine and Huffman 1990)

Appendix 2. (continued)

Consequence (Dependent Variable)	Nutrition Indicators (Independent Variables)	Estimation Approach	Key Sources
10. Labor productivity			
Current productivity of agricultural workers	IRON (adults)	Average productivity by severity of deficiency	(Basta et al. 1979, Levin et al. 1993)
Discounted future lost wages due to childhood nutritional disabilities	HA, IOD, New cases of complete and partial blindness {NB}	Average productivity by severity	(Behrman 1993, Clugston et al. 1987, Haas et al. 1995, Huffman et al. 1991, Levin et al. 1993, Martorell et al. 1991, Pinstrup-Andersen et al. 1993, Rivera et al. 1995)
Discounted future lost wages due to child deaths	Stillbirths + neonatal deaths {BW, IOD, IRON, Initiate BF}, Child deaths 1–59 mo. {FM, VA, WA}	Replaced deaths not counted; living costs not accounted for	(UN Secretariat 1988)
11. Other economic consequences			
TFR replacement cost	Total fertility rate {BF duration}	Equivalent family planning program	(See total fertility rate consequence)
Livestock production	Prevalence of iodine deficiency in livestock		(Dunn and Van Der Haar 1990, Pandav 1994)

Braces ({ }) enclose the independent nutrition variables that influence the dependent consequence that precede the braces.

Notes: BF ' breastfeeding. BW ' birth weight incidence. FM ' feeding mode. HA ' height-for-age prevalence. IOD ' goiter prevalence. IRON ' iron deficiency anemia prevalence. NB ' night blindness prevalence. PAR ' population attributable risk. TFR ' total fertility rate. VA ' vitamin A deficiency based on serum retinol level. WA ' weight-for-age prevalence.

Endnotes

1. In algebraic terms, total costs in any year T can be calculated by the following equation:

$$TotalCost_T = C1_T + C2 \times Participants_T + C3 \times NetNewEnrollees_T$$

where $C1_T$ is the fixed cost in year T, $C2$ is annual per participant maintenance cost, and $C3$ is the one-time per person enrollment cost. Note that $C2$ and $C3$ do not vary from year to year, but $C1$ can. The last term, representing the one-time enrollment costs in year T, is not allowed to be negative.

2. In algebraic terms, the impact of the program for a particular nutrition indicator (ni) and population group (p) in any year T is calculated by the following equation:

$$Impact_{p,ni,T} = (Cover_{p,T}) \times (Effect_{p,ni,T}) \times (TargetPopul_T) \times (DeficienPreval_{p,ni,T})$$

Note that all four factors (coverage, effectiveness, target population, and deficiency prevalence) can vary by year, but that the target population does not vary by population group or nutrition indicator, and coverage does not vary by nutrition indicator.

3. In general, different nutritional insults early in life can cause permanent damage that result in a lifetime of reduced wages. To compute the present value of the lifetime of lost earnings, beginning with the year that the disabling event occurred, PROFILES defines a lifetime discounting factor for each type of nutritional disability that is a function of (1) the age at which the disabling event occurs, (2) the ages of entry and exit to the workforce (typically 15 and 64 years), (3) the annual discount rate (typically 3 percent), and (4) the probability of surviving to each future wage-earning year.

4. The Bangladesh Integrated Nutrition Project includes numerous components, such as village nutrition workers, growth monitoring, food, micronutrient supplementation, nutrition education and community organization; it is based to a large extent on the Tamil Nadu Integrated Nutrition Project in southern India.

5. The seven Asian countries involved in the Asian Development Bank/UNICEF regional projects are Bangladesh, Cambodia, China, India, Pakistan, Sri Lanka, and Vietnam.

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