Food Fortification in Asia: Improving Health and Building Economies

An Investors Primer, Summarizing Investment Plans for Five Asian Countries

Developed by the Governments of Indonesia, Pakistan, People's Republic of China, Thailand, and Viet Nam, with Assistance from the Asian Development Bank and The Keystone Center

June 2004
THE ASIAN DEVELOPMENT BANK NUTRITION AND DEVELOPMENT SERIES

The ADB Nutrition and Development Series was started in 2001 by Dr Joseph Hunt and covers the impact of malnutrition in Asia and the Pacific on poverty and depressed human and economic development. The Series stresses three themes: targeting nutrition improvements at poor women and children, with benefits to families, communities, and nations throughout the life cycle; reviewing and applying scientific evidence about nutrition impact for policies, programs, and developmental assistance that will raise the quality of human resources; and, creating opportunities for public, private, and civil sector partnerships that can raise the dietary quality of the poor; and enhance the learning and earning capability of poor children. The Series is intended for ADB member countries, development partners, and scholars interested in applying science and technology to investment decisions.

For more information please contact Dr Lisa J. Studdert: lstuddert@adb.org; ph: (632) 632-4444; fax (632) 636-2444.
Foreword

Improvements in human health lie at the heart of the Millennium Development Goals, which chart progress in reducing poverty in the developing world. This book takes a novel approach to showing how health and mental development can be improved by strengthening the food industry in Asia.

Based on an Asian Development Bank (ADB) investment planning exercise, five Asian countries (Indonesia, Pakistan, People's Republic of China, Thailand, and Viet Nam) have identified foods consumed by the poor and estimated the benefits and costs of fortifying those foods with essential micronutrients (vitamins and minerals). The results are stunning. For example, in the five countries where iron deficiency anemia is a public health issue, a variety of food vehicles can deliver iron in a package of micronutrients to one billion persons at $0.08 per person per year. The benefits include reduced maternal deaths among anemic women and normal brain development among young children whose capacity to learn in school and advance in workplace achievement would otherwise be compromised.

This book synthesizes the findings of the country studies with interesting conclusions, such as:

- delivering essential micronutrients through the food sector is good public health policy;
- fortification technology is proven, cheap, and effective;
- fortification is part of an integrated strategy to improve health but it definitely fills a niche;
- public-private partnerships create public goods for the poor but with efficiency gains arising from private sector competition;
- benefits to human health and productivity are impressive, at costs that match the best public health interventions;
- good food production technologies, supported by legislative, regulatory, and trade reforms raise human capital through the market, and thereby save public health resources that can be put to better use, and strengthen Asia's clout in global food trade; and
- governments, donors, and civil society are the components of an important alliance to make food fortification into a regional public good that protects human health and builds economies.

ADB is pleased to share the results of its regional work on food fortification with colleagues, and looks forward to further dialogue with partners on how to make applied food science and technology available to Asia's poor consumers. This marriage of industrial and health policy is promising.

Geert van der Linden
Vice President
Knowledge Management and Sustainable Development
Asian Development Bank
The opportunity exists now to save more than a quarter of a million lives over the next 10 years in Indonesia, Pakistan, People's Republic of China, Thailand, and Viet Nam by fortifying basic foods with vitamins and minerals. Reducing micronutrient deficiencies via fortification will help to fuel economies by lowering health care costs and increasing worker productivity. Also, fortification will improve the cognitive development of children, which in turn will expand and sustain economic development for years to come.

Food fortification is one of several strategies that can lift the tremendous human and economic burden of micronutrient deficiencies and malnutrition in Asia. And it is one of the most promising. With sometimes half of a nation's population suffering from vitamin and mineral deficiencies, the fortification of common processed foods is an intervention that can protect large populations using sustainable market channels. With food fortification strategies supported and maintained through the market system, government resources and public health systems are freed to target the very poor who will not be effectively reached and require different intervention strategies.

This Investors Primer contains summaries of Country Investment Plans (CIPs) for Indonesia, Pakistan, People's Republic of China, Thailand, and Viet Nam. The CIP summaries outline proposed fortification projects that, if implemented, would protect more than one billion people in these five countries, every day. The consequent reductions in micronutrient deficiencies are projected to unlock more than $4.5 billion in national economic benefits. These vast health, social, and productivity improvements can be leveraged through pump-priming investments of approximately $100 million over 10 years.

To develop the CIPs, the Asian Development Bank and The Keystone Center spent two years collaborating with multisectoral Country Teams in the five countries of interest. The members of the Country Teams conducted the relevant research and analysis, and the CIPs they developed offer concrete and realistic fortification projects and define needed investments to improve health and build economies. The most up-to-date CIPs are available in their entirety from the principal investigators for each Country Team, to assist in due diligence. (See Annex A.) This document provides an overview of the investment opportunities, describes the analysis and consensus on which the CIPs rest, and summarizes each CIP project. The Country Teams are now working to match their fortification projects with a wide variety of financial partners, including domestic and international corporations, industry associations, international aid agencies and bilateral donors, and private philanthropies.
Acknowledgment

The special relationships formed in the course of preparing the Country Investment Plans will influence future partnerships within the five Asian countries and with donor partners seeking to build upon the findings of the plans. The country teams have brought leaders in the public and private sectors together in a unique way, and all stakeholders are prepared to take the recommendations of their plans to full resolution. My appreciation for the country teams, as well as the contributions of The Keystone Center for its strong advisory role to the planning process, is considerable.

I wish to acknowledge the contributions of the country team leaders and principal investigators: Dr. Dipo Alam and Dr. Hardinsyah, Indonesia; Mr. Mohammad Ayub and Dr. Abdul Kemal, Pakistan; Professor Yu Xiaodong and Dr. Sun Xuegong, People’s Republic of China; Dr. Sangsom Sinawat and Dr. Visith Chavisit, Thailand; and Dr. Nguyen Cong Khan and Dr. Nguyen Xuan Ninh, Viet Nam. Their patient deliberation and vision for a future free of micronutrient malnutrition are impressive.

The joint leadership of Tom Grumbly and Jack Bagriansky set the tone for the valuable contribution of The Keystone Center team, which brought a capacious intelligence and deep commitment to seeing the potential of food technology reach the needy in all the countries. Keystone’s Brad Sperber provided the careful and consistent management that made the regional and country consultations effective fora for communications and decision-making. The following consultants provided an opportunity for the country teams to test state-of-the-art approaches to food technology, planning, regulation, and economic assessment with a broad range of professional experiences across the world: Bienvenido Alano, Peter Adler, Jack Fiedler, Quentin Johnson, Rose Nathan, George Purvis, Kevin Sullivan, Herbert Weinstein, and Abraham Varghese.

A new dialogue has opened in Asia, about the convergence of industrial and health policy to solve nutrition problems that hold back the region. I look forward to seeing the country plans being realized and then replicated throughout Asia in the future.

Joseph M. Hunt
# Contents

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foreword</td>
<td>iii</td>
</tr>
<tr>
<td>Preface</td>
<td>v</td>
</tr>
<tr>
<td>Acknowledgment</td>
<td>vii</td>
</tr>
<tr>
<td>Executive Summary</td>
<td>xi</td>
</tr>
<tr>
<td>Introduction</td>
<td>1</td>
</tr>
<tr>
<td>A Compelling Solution</td>
<td>2</td>
</tr>
<tr>
<td>A Focus on the Working Poor</td>
<td>3</td>
</tr>
<tr>
<td>Enhancing Market Development</td>
<td>4</td>
</tr>
<tr>
<td>New Market Paradigm</td>
<td>4</td>
</tr>
<tr>
<td>Public-Private Partnerships for Program Success and Market Development</td>
<td>4</td>
</tr>
<tr>
<td>Chapter 1: Process</td>
<td>6</td>
</tr>
<tr>
<td>Building Capacity, Consensus, and Collaboration</td>
<td>7</td>
</tr>
<tr>
<td>National Ownership</td>
<td>7</td>
</tr>
<tr>
<td>Collaboration among the Public, Private, and Civic Sectors</td>
<td>8</td>
</tr>
<tr>
<td>Implementation</td>
<td>8</td>
</tr>
<tr>
<td>Regional Capacity Building and Decision Making</td>
<td>8</td>
</tr>
<tr>
<td>Chapter 2: Methodology</td>
<td>13</td>
</tr>
<tr>
<td>An Analytical Framework for the Country Investment Plans</td>
<td>13</td>
</tr>
<tr>
<td>The Need for a New Framework for Analysis</td>
<td>14</td>
</tr>
<tr>
<td>Determining the Costs of Micronutrient Malnutrition</td>
<td>15</td>
</tr>
<tr>
<td>Projecting the Benefits of Fortification</td>
<td>17</td>
</tr>
<tr>
<td>Conservative Approaches</td>
<td></td>
</tr>
<tr>
<td>Chapter 3: Product</td>
<td>19</td>
</tr>
<tr>
<td>Country Investment Plans and Supporting Information</td>
<td>20</td>
</tr>
<tr>
<td>Two Environments for Flour Fortification in Asia</td>
<td>24</td>
</tr>
<tr>
<td>New Products to Address Micronutrient Malnutrition in Asia:</td>
<td>24</td>
</tr>
<tr>
<td>Fish Sauce and Soy Sauce Fortification</td>
<td>24</td>
</tr>
<tr>
<td>Investing in Complementary Foods: New Approaches to Reaching the</td>
<td>31</td>
</tr>
<tr>
<td>Most Vulnerable Population in Asia</td>
<td>38</td>
</tr>
<tr>
<td>Developing the Case for Oil Fortification</td>
<td>34</td>
</tr>
<tr>
<td>Indonesia CIP Summary</td>
<td>36</td>
</tr>
<tr>
<td>Pakistan CIP Summary</td>
<td>36</td>
</tr>
<tr>
<td>Section</td>
<td>Page</td>
</tr>
<tr>
<td>---------------------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>People's Republic of China CIP Summary</td>
<td>39</td>
</tr>
<tr>
<td>Thailand CIP Summary</td>
<td>42</td>
</tr>
<tr>
<td>Viet Nam CIP Summary</td>
<td>44</td>
</tr>
<tr>
<td><strong>Annex A</strong></td>
<td></td>
</tr>
<tr>
<td>Biodata for Key Contributors</td>
<td>49</td>
</tr>
<tr>
<td><strong>Annex B</strong></td>
<td></td>
</tr>
<tr>
<td>Consensus Statements from Project Workshops</td>
<td>55</td>
</tr>
<tr>
<td><strong>Annex C</strong></td>
<td></td>
</tr>
<tr>
<td>Estimation of the Impact of Vitamin A Fortified Foods on the Prevalence of Vitamin A Deficiency</td>
<td>67</td>
</tr>
<tr>
<td><strong>Annex D</strong></td>
<td></td>
</tr>
<tr>
<td>Estimation of the Impact of Iron Fortification on the Prevalence of Anemia</td>
<td>71</td>
</tr>
<tr>
<td><strong>Annex E</strong></td>
<td></td>
</tr>
<tr>
<td>The PROFILES Model: Underlying Principles and Assumptions</td>
<td>75</td>
</tr>
<tr>
<td><strong>Annex F</strong></td>
<td></td>
</tr>
<tr>
<td>Product Profiles</td>
<td>81</td>
</tr>
<tr>
<td><strong>Annex G</strong></td>
<td></td>
</tr>
<tr>
<td>Glossary</td>
<td>83</td>
</tr>
<tr>
<td><strong>Annex H</strong></td>
<td></td>
</tr>
<tr>
<td>Acronyms</td>
<td>84</td>
</tr>
</tbody>
</table>
Executive Summary

The persistence of micronutrient deficiencies in Asia is alarming and is damaging to lives and economies. The Asian Development Bank (ADB) has assisted five Asian nations in identifying ways to eliminate these deficiencies. In Indonesia, Pakistan, People's Republic of China (PRC), Thailand, and Viet Nam, the lack of dietary micronutrients—including key vitamins and minerals such as iron and vitamin A—will take a toll of more than one million lives over the next 10 years. In addition to causing the loss of precious human life, these vitamin and mineral deficiencies depress cognitive and physical development in young children, stifling educational performance and depressing future productivity. In adults, iron deficiency anemia (IDA) causes a debilitating fatigue that lowers work output in the agriculture, construction, and other manual-labor and blue-collar sectors. Even greater losses are suffered from low cognitive development in early childhood that depresses schooling achievement and later professional wages as white-collar workers. In these five countries, the 10-year productivity loss associated with IDA alone is projected at more than $25 billion.

An effective mix of low-cost food-based, pharmaceutical, behavioral, and public health interventions can offer substantial protection from vitamin and mineral deficiencies. Food fortification—the addition of minute quantities of vitamins and minerals to common processed foods—can protect large populations that are often beyond the reach of health systems. ADB and the World Bank have identified micronutrient interventions as among the most cost-effective of development investments.

From August 2001 through mid-2003, multisectoral Country Teams from Indonesia, Pakistan, PRC, Thailand, and Viet Nam participated in ADB’s Regional Initiative to Eliminate Micronutrient Malnutrition through Public-Private Partnership. The five participating countries each produced 10-year Country Investment Plans (CIPs), which propose national food fortification programs to reduce the high prevalence of micronutrient deficiencies.

Over the next 10 years, the 14 fortification projects proposed in the five CIPs are projected to save more than 280,000 lives and reduce the economic burden with estimated savings of more than $4.5 billion. The total cost of these interventions is about three-quarters of $1 billion, most of which is absorbed by the food market. International investments of approximately $100 million are sought, mainly to provide incentives for initial investment in production and the building of critical public systems, including regulation, monitoring, and public education.

The CIPs were developed through a collaborative process of cross-sector information sharing, capacity building, advocacy, and financial and public health analysis. The plans are the result of two years work by the five Country Teams, with technical assistance from ADB, the US-based nonprofit The Keystone Center, and other national and regional institutions. The Country Teams, whose membership reflects the breadth of public, private, and civic society, undertook the actual analysis, identified priorities, and recommended investments. This national ownership positions the CIPs for successful implementation.

The CIPs are founded on a regional consensus regarding the need for regulatory and trade structures to support investment in fortification. In a series of workshops, Country Team participants developed consensus statements that encouraged the building...
of regional institutional capacity in food quality assurance, nutrition monitoring, communications, and advocacy. Participants in these multisectoral workshops also adopted regional guidelines for fortified flour, oil, and “complementary” foods.

The specific fortification projects outlined in the CIPs were identified on the basis of a feasibility analysis assessing industrial capacity and commercial potential in each country, as well as the projected impact of fortification on the prevalence of micronutrient deficiencies. A benefit-cost analysis model, developed specifically for the project, provides country-specific information regarding:

- implementation needs, capital investments, and recurring costs;
- government costs for food control, public education, and monitoring systems;
- best estimates for the protection of low-income and at-risk consumers based on consumer intake, industry coverage, and other factors;
- projections for reductions in the national prevalence of IDA and vitamin A deficiency (VAD), and estimated impacts of the addition of dietary folic acid; and
- a financial summary reviewing benefits and costs on annual and 10-year bases.

All five CIPs include a recommendation for investment in wheat flour fortification. In Pakistan and the western provinces of the PRC, flour products are staple foods consumed throughout rural and low-income populations. Given the high flour consumption among the poor, fortification promises significant reductions in IDA and folic acid deficiency (FAD). However, upgrading the traditional marketplace, including older production facilities and multiple small producers, represents a challenge for public policy and implementation. In Southeast Asian countries, centralized and modern flour production means that fortification technologies can be implemented in a relatively straightforward manner. The benefit-cost ratios for the flour fortification projects proposed in the CIPs range from nearly 2:1 to more than 9:1, but approach the higher estimate when subsidies of fortificant costs to the flour industry are eliminated.

While rice fortification in Asia presents a number of technical barriers, the recent development of technology to fortify fish sauce and soy sauce offers an alternative strategy to protect rice-eating populations against IDA, including rural and low-income people. The CIPs for PRC, Thailand, and Viet Nam propose fortification strategies with estimated reductions in the prevalence of IDA of up to one-third. The projected 10-year benefit-cost ratios range from 7:1 in Thailand to nearly 12:1 in Viet Nam. These new food fortification vehicles have already undergone a three-year process of technical development, product testing, consumer acceptance, and effectiveness trials.

Micronutrient deficiencies in children aged 6-24 months represent a grave threat and a critical need. Young children who are micronutrient deficient are likely to be underweight, have their growth stunted, perform poorly in school, and earn wages later in life well below their potential. They also often die prematurely. The CIPs for Indonesia, PRC, Thailand, and Viet Nam offer distinct approaches to reaching this critical segment with fortified complementary foods for young children via new partnerships, new products, and new marketing systems. These foods will help to optimize child growth and mental development during life’s “window of opportunity,” i.e., the first 2 years. The approaches range from capitalizing on available but unused production capacity to the development of new rural food enterprises. Proposals for blended public-private distribution systems promise penetration into the most at-risk areas. Projected coverage ranges from 15% in rural Viet Nam to 50% in rural Indonesia and 100% of the most at-risk children in selected western provinces of the PRC. By targeting the most vulnerable populations in Asia at this critical time in their lives, the returns in lives saved will be considerable, and the savings in reduced sickness and future productivity will be enormous.

Finally, the fortification of cooking oils in Indonesia, Pakistan, and PRC with vitamin A promises significant benefits in the reduction of child

---

1 The consensus statements are available in Appendix B, p. 101 ff.
2 Complementary foods are semisolid foods fed to infants and very young children as a complement to breast-feeding or commercial or homemade formula.
3 Underweight preschoolers are at highest risk of premature death. Complementary foods address underweight and micronutrient deficiencies simultaneously, thus reducing two critical risk factors for mortality.
mortality and health care costs. Public health programs have done a good job of distributing vitamin A capsules twice a year to children under the age of five, and the clinical form of VAD that leads to blindness has been reduced. But the absence of staple foods enriched with vitamin A leaves a third of Asian children with subclinical VAD, which is the principal risk factor in the mortality of young children with communicable diseases like diarrhea and measles. That is why fortified staples like oil are essential to achieving the United Nations’ Millennium Development Goal (MDG) of reducing under-5 child mortality by two-thirds by 2015. Given the centralized nature of the vegetable oil industry, the projected expenses for industrial upgrades and government food control and regulation are relatively modest. However, a number of technical issues remain to be resolved. Based on positive feasibility assessments for national programs in the three countries, product development and testing are proposed.

This Investors Primer provides an overview of the investment opportunities widely available in Asia to reach the poor through micronutrient enrichment of dietary staples. The table on the following page summarizes the 14 specific projects proposed in the CIPs, and each of these projects is discussed in more detail in Chapter 3. These food fortification initiatives can contribute to the MDGs for health, including reducing infant, under-5 child, and maternal mortality rates, reducing hunger, and helping to ensure that children complete their primary education (by raising their cognitive capacity).

The key to fortification is its flexibility in delivering benefits within current food patterns across the region. Fortification of a few food vehicles (such as flour and condiments) in just five countries, along with $80 million in seed financing and almost $700 million in domestic financing over 10 years, could deliver iron and folic acid to one billion people at a cost of about eight US cents per person and a benefit-cost ratio of about 6:1. A real bargain! The investment model for selected countries provides a compelling case for resource mobilization in the region.
### Summary of Costs and Benefits for the 14 Fortification Projects Proposed in the CIPs
(in $ thousands and thousands of deaths averted)

<table>
<thead>
<tr>
<th>Country and Project</th>
<th>Projected 10-Year Costs** ($'000)</th>
<th>Projected 10-Year Benefits ($'000)</th>
<th>Deaths Averted</th>
<th>Health Care Cost Saved*** ($'000)</th>
<th>Productivity Gained**** ($'000)</th>
<th>Seed Financing Request % of 10-year cost</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Indonesia</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wheat Flour</td>
<td>20,586</td>
<td>104,134</td>
<td>111</td>
<td>924</td>
<td>103,210</td>
<td>24%</td>
<td>4,852,770</td>
</tr>
<tr>
<td>Cooking Oil</td>
<td>60,372</td>
<td>666,377</td>
<td>44</td>
<td>555,802</td>
<td>$110,575</td>
<td>22%</td>
<td>13,396,889</td>
</tr>
<tr>
<td>Comp. Foods</td>
<td>67,138</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>27%</td>
<td>17,928,440</td>
</tr>
<tr>
<td><strong>Pakistan</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wheat Flour</td>
<td>165,594</td>
<td>337,862</td>
<td>38</td>
<td>9,603</td>
<td>328,259</td>
<td>22%</td>
<td>37,006,536</td>
</tr>
<tr>
<td>Cooking Oil</td>
<td>35,833</td>
<td>138,260</td>
<td>42</td>
<td>18,234</td>
<td>120,026</td>
<td>22%</td>
<td>7,836,512</td>
</tr>
<tr>
<td><strong>PRC</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Soy Sauce</td>
<td>240,238</td>
<td>2,250,238</td>
<td>0.5</td>
<td>2,250,056</td>
<td></td>
<td>1%</td>
<td>3,071,000</td>
</tr>
<tr>
<td>Wheat Flour</td>
<td>184,125</td>
<td>543,346</td>
<td>32</td>
<td>5,195</td>
<td>538,151</td>
<td>5%</td>
<td>8,702,000</td>
</tr>
<tr>
<td>Comp. Foods</td>
<td>14,323</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>36%</td>
<td>5,162,170</td>
</tr>
<tr>
<td><strong>Thailand</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fish Sauce</td>
<td>24,463</td>
<td>160,725</td>
<td>0.014</td>
<td>160,725</td>
<td></td>
<td>5%</td>
<td>1,221,952</td>
</tr>
<tr>
<td>Wheat Flour</td>
<td>2,759</td>
<td>13,404</td>
<td>5</td>
<td>384</td>
<td>13,019</td>
<td>18%</td>
<td>490,739</td>
</tr>
<tr>
<td>Comp. Foods</td>
<td>3,796</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>14%</td>
<td>525,614</td>
</tr>
<tr>
<td><strong>Viet Nam</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fish Sauce</td>
<td>21,740</td>
<td>257,825</td>
<td>0.8</td>
<td>257,825</td>
<td></td>
<td>19%</td>
<td>4,089,300</td>
</tr>
<tr>
<td>Wheat Flour</td>
<td>3,815</td>
<td>37,104</td>
<td>8</td>
<td>2,216</td>
<td>34,889</td>
<td>18%</td>
<td>669,926</td>
</tr>
<tr>
<td>Comp. Foods</td>
<td>43,637</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>15%</td>
<td>6,516,161</td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td>759,347*</td>
<td>4,509,275</td>
<td>281</td>
<td>592,358</td>
<td>3,916,735</td>
<td>13%</td>
<td>81,337*</td>
</tr>
</tbody>
</table>

* Totals are exclusive of complementary foods proposals. Sums in Table 7 include complementary foods proposals.
** Costs are broken down in more detail in Table 7.
*** Health Care Costs Saved through lower utilization of health care services by children and/or adults.
**** Gained Productivity from: (a) higher future productivity due to improved cognitive development in children; (b) higher current productivity in adults engaged in blue collar and heavy manual labor; and (c) discounted future lifetime earnings of children whose deaths were averted.
Dietary deficits in minute amounts of key vitamins and minerals, known as micronutrients, have emerged as the most widespread and devastating nutritional deficiencies on earth. The crushing impact of micronutrient malnutrition on survival, growth, health, intelligence, and productivity has been well documented. Worldwide, more than three billion people are prevented from achieving their full potential as students, parents, workers, and citizens due to micronutrient deficiencies. Three fourths of those affected are in Asia, where vitamin A deficiency (VAD), folic acid deficiency (FAD), and iron deficiency anemia (IDA) represent a serious burden on public health and national development. Table 1 shows the percentage of the populations of Indonesia, Pakistan, People's Republic of China (PRC), Thailand, and Viet Nam that suffers from VAD and IDA, as reported by the Country Teams that developed the Country Investment Plans (CIPs) summarized in this report.

In these five nations, more than one million people are projected to die in the next 10 years due to dietary deficits in iron and vitamin A. Children under the age of 5 with compromised immune systems as a consequence of VAD will succumb to a variety of infections. Anemic women will die in childbirth. Table 2 outlines the projected number of deaths attributable to micronutrient deficiencies in each country of interest over the next 10 years, as estimated by the Country Teams.

Beyond causing the loss of precious human life, vitamin and mineral deficiencies cause immense suffering and impose large economic losses on Asian societies. The debilitating fatigue and weakness of anemia causes lower work output in the agriculture, construction, and other manual-labor and blue-collar sectors. The lack of iron in the diets of young children impairs cognitive growth, intelligence, and school performance, which ultimately translates into future productivity deficits.

Table 3 reveals that, in the five countries analyzed for this report, the 10-year productivity loss associated with iron deficiency anemia is projected

---

**TABLE 1: Percentage of the Population with Vitamin A Deficiency and Iron Deficiency Anemia in Five Asian Countries**

<table>
<thead>
<tr>
<th>Vitamin A Deficiency</th>
<th>Indonesia</th>
<th>Pakistan</th>
<th>PRC</th>
<th>Thailand</th>
<th>Viet Nam</th>
</tr>
</thead>
<tbody>
<tr>
<td>Children 6-59 Months</td>
<td>50%</td>
<td>24%</td>
<td>28%</td>
<td>20%</td>
<td>22%</td>
</tr>
<tr>
<td>Iron Deficiency Anemia</td>
<td>51%</td>
<td>41%</td>
<td>31%</td>
<td>22%</td>
<td>53%</td>
</tr>
<tr>
<td>Pregnant Women</td>
<td>40%</td>
<td>40%</td>
<td>22%</td>
<td>18%</td>
<td>40%</td>
</tr>
<tr>
<td>Adult Females</td>
<td>20%</td>
<td>29%</td>
<td>15%</td>
<td>16%</td>
<td>16%</td>
</tr>
<tr>
<td>Adult Males</td>
<td>41%</td>
<td>51%</td>
<td>17%</td>
<td>25%</td>
<td>45%</td>
</tr>
<tr>
<td>Children</td>
<td>41%</td>
<td>51%</td>
<td>17%</td>
<td>25%</td>
<td>45%</td>
</tr>
</tbody>
</table>

---

5 Figures are drawn from the Country Investment Plans.
4 IDA refers to anemia due to a lack of iron intake, as opposed to other factors like malaria or parasitic diseases.
5 Note that, throughout this report, the figures for the PRC reflect data only for its 12 northwestern provinces, unless otherwise noted.
6 Insufficient folic acid will cause needless birth defects and coronary heart disease (CHD). While averted cases are projected in the CIPs (based on evidence from Canada and the United States), there is no established relative risk of morbidity or mortality in these instances. Therefore, folic acid is not included in Table 2.
TABLE 2: Deaths Projected to be Caused by Micronutrient Deficiencies
Over a Ten-Year Period

<table>
<thead>
<tr>
<th></th>
<th>VAD</th>
<th>IDA</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Children &lt; 60 months</td>
<td>Mothers in Childbirth</td>
<td></td>
</tr>
<tr>
<td>Indonesia</td>
<td>320,208</td>
<td>39,880</td>
<td>360,088</td>
</tr>
<tr>
<td>Pakistan</td>
<td>432,043</td>
<td>41,920</td>
<td>473,963</td>
</tr>
<tr>
<td>PRC (NW)</td>
<td>166,190</td>
<td>20,344</td>
<td>186,543</td>
</tr>
<tr>
<td>Thailand</td>
<td>23,944</td>
<td>619</td>
<td>24,563</td>
</tr>
<tr>
<td>Viet Nam</td>
<td>50,404</td>
<td>7,212</td>
<td>57,616</td>
</tr>
<tr>
<td>Total</td>
<td>992,789</td>
<td>109,975</td>
<td>1,102,773</td>
</tr>
</tbody>
</table>

TABLE 3: Projected Ten-Year Productivity Impact of IDA
($ million)

<table>
<thead>
<tr>
<th></th>
<th>Future Losses</th>
<th>Current Labor Losses</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Child Cognition</td>
<td>Blue Collar</td>
<td>Heavy Manual</td>
</tr>
<tr>
<td>Indonesia</td>
<td>1,948</td>
<td>1,428</td>
<td>2,379</td>
</tr>
<tr>
<td>Pakistan</td>
<td>1,709</td>
<td>352</td>
<td>821</td>
</tr>
<tr>
<td>PRC (NW)</td>
<td>1,486</td>
<td>3,830</td>
<td>8,165</td>
</tr>
<tr>
<td>Thailand</td>
<td>254</td>
<td>1,298</td>
<td>435</td>
</tr>
<tr>
<td>Viet Nam</td>
<td>410</td>
<td>295</td>
<td>707</td>
</tr>
<tr>
<td>Total</td>
<td>5,807</td>
<td>7,203</td>
<td>12,507</td>
</tr>
</tbody>
</table>

by the Country Teams at more than $25 billion. The
fortification projects proposed in this report could,
according to Country Teams, prevent $3.9 billion of
these losses.

The remainder of this introduction explains why
food fortification is such a compelling and achievable
solution to the terrible consequences of micronutrient
deficiencies. Chapter 1 then discusses the capacity-
and consensus-building process used to develop the
five CIPs summarized herein. It also includes excerpts
from consensus statements developed at several key
workshops along the way. Chapter 2 outlines the
methodology used by the Country Teams to
determine the costs and benefits of the various
fortification proposals. (Annexes C, D, and E describe
this methodology in greater technical detail.) Finally,
Chapter 3 contains summaries of the five CIPs and
supporting information regarding the types of
fortification projects that are proposed. (Annex F
contains brief profiles of each project.)

---

by the country teams at more than $25 billion. The
fortification projects proposed in this report could,
according to country teams, prevent $3.9 billion of
these losses.

The remainder of this introduction explains why
food fortification is such a compelling and achievable
solution to the terrible consequences of micronutrient
deficiencies. Chapter 1 then discusses the capacity-
and consensus-building process used to develop the
definitions. Chapter 1 then discusses the capacity-
and consensus-building process used to develop the
definitions. Chapter 1 then discusses the capacity-
and consensus-building process used to develop the
definitions. Chapter 1 then discusses the capacity-
and consensus-building process used to develop the
definitions. Chapter 1 then discusses the capacity-
and consensus-building process used to develop the
definitions. Chapter 1 then discusses the capacity-
and consensus-building process used to develop the
definitions. Chapter 1 then discusses the capacity-
and consensus-building process used to develop the
definitions. Chapter 1 then discusses the capacity-
and consensus-building process used to develop the
definitions. Chapter 1 then discusses the capacity-
and consensus-building process used to develop the
definitions. Chapter 1 then discusses the capacity-
and consensus-building process used to develop the
definitions. Chapter 1 then discusses the capacity-
and consensus-building process used to develop the
definitions. Chapter 1 then discusses the capacity-
and consensus-building process used to develop the
definitions. Chapter 1 then discusses the capacity-
and consensus-building process used to develop the
definitions. Chapter 1 then discusses the capacity-
and consensus-building process used to develop the
definitions. Chapter 1 then discusses the capacity-
and consensus-building process used to develop the
definitions. Chapter 1 then discusses the capacity-
and consensus-building process used to develop the
definitions. Chapter 1 then discusses the capacity-
and consensus-building process used to develop the
definitions. Chapter 1 then discusses the capacity-
and consensus-building process used to develop the
definitions. Chapter 1 then discusses the capacity-
and consensus-building process used to develop the
definitions. Chapter 1 then discusses the capacity-
and consensus-building process used to develop the
definitions. Chapter 1 then discusses the capacity-
and consensus-building process used to develop the
definitions. Chapter 1 then discusses the capacity-
and consensus-building process used to develop the
definitions. Chapter 1 then discusses the capacity-
and consensus-building process used to develop the
definitions. Chapter 1 then discusses the capacity-
and consensus-building process used to develop the
definitions. Chapter 1 then discusses the capacity-
and consensus-building process used to develop the
definitions. Chapter 1 then discusses the capacity-
and consensus-building process used to develop the
definitions. Chapter 1 then discusses the capacity-
and consensus-building process used to develop the
definitions. Chapter 1 then discusses the capacity-
and consensus-building process used to develop the
definitions. Chapter 1 then discusses the capacity-
and consensus-building process used to develop the

---

1 In Table 3, the figures for the PRC reflect only the northwest provinces.

A Compelling Solution

Adding minute levels of vitamin A, folic acid, and
other micronutrients to commonly consumed foods
may offer one of the most sustainable and cost-
effective strategies to deliver key micronutrients to
the large populations of low-income and at-risk
people who desperately need them. The technology
is simple. Product quality is unaffected. Incremental
price is usually invisible. And consumers are provided
with a significant percentage of their daily
micronutrient needs.

Since the early 1900s, fortification by a number
of food industries has played a major role in the near
elimination of vitamin and mineral deficiencies in
many industrialized nations. In the developing world,
since a campaign to eliminate iodine deficiency
disorders began in the early 1990s, more than 30
countries have implemented effective and sustainable
systems to fortify salt with iodine. The percentage of
the global population with access to iodized salt
increased from 20% to 70% during the past decade,
and public investment of $400 million has leveraged
more than $1.5 billion of private investment in salt iodization, mostly from the salt industry. This is testimony to the power of well-articulated and targeted joint action. In Latin America, countries have also addressed other micronutrient deficiencies through fortification. For example, Guatemala has halved the prevalence of VAD among its population with a national sugar fortification program. But for most of the developing world, food fortification remains a vastly underutilized opportunity.

The viability of fortification as a feasible, cost-effective, and sustainable strategy for reducing micronutrient deficiencies in Asia depends on a number of success factors, including the following:

- **Access**: an overlap in the consumption of processed foods with the population at risk of vitamin and mineral deficiency
- **Product**: a food vehicle that can deliver micronutrients in amounts that are bioavailable (i.e., can be absorbed and utilized by the body), safe, and effective, with no perceived or unacceptable changes in quality
- **Production**: industry with the technical capacity to efficiently produce, ensure the quality of, and distribute fortified foods to wide markets, including low-income rural areas
- **Business**: a business and trade environment that is reasonably fair and stable, and an incremental price increase that does not affect projected consumption by low-income consumers
- **Governance**: public institutions with the commitment and capacity to ensure a level playing field, thereby ensuring the safety, quality, and consistency of the food supply and monitoring health outcomes

In the five Asian countries discussed in this report, many—though not all—of these conditions exist now. And each CIP proposes to build capacity to expand on these success factors for the future. The CIPs work to capitalize on the overlap between the population consuming processed foods and the population at risk of micronutrient deficiencies. Each proposed fortification program is built on product development—either previously implemented or proposed—as well as a realistic analysis of industrial capacity and the business environment. And in all of the CIPs, government commitment is clearly outlined and the need for capacity building and reform is recognized and addressed.

The resource needs articulated in each of the five CIPs reflect the different mix of existing success factors. Some require outside resources to jump-start domestic investment, production, and marketing, while others propose to develop the infrastructure necessary for success. In all cases, the CIPs make innovative proposals for how to achieve results within the 10-year time frame. The CIPs indicate positive benefit-cost ratios and high internal rates of return over 10 years for all of the proposed fortification initiatives.

**A Focus on the Working Poor**

From the perspective of governments working to reduce micronutrient malnutrition, fortification is an attractive and sustainable solution because it shifts the financial burden for addressing this serious public health problem to the marketplace. Market forces drive fortification; consumers ultimately finance it through small, essentially invisible changes in retail price. Therefore, fortified foods will primarily reach those people who have at least some money to purchase food (though some fortified foods may be given away in specific public distribution programs).

Those who exist on subsistence diets and do not participate in the cash economy will probably not benefit from this market-based intervention. That population will continue to rely upon other interventions subsidized by the state in public assistance programs—food-based, pharmaceutical-based, and other—to improve their diets. However, fortification will provide significant benefits to the working poor—that vast group of individuals who have jobs, raise families, drive the economy, and ultimately determine the future productivity of their nations. Their productivity expands economies, and their purchasing power makes fortification sustainable.

Fortification is thus a “win-win” proposition—it improves both economic development and health protection. It better the lives of the working poor, which in turn fuels economic development. At the same time, public health and welfare agencies can reallocate their resources and focus their activities specifically to those individuals who are not served by fortification and so continue to need public assistance.
Enhancing Market Development

Because food fortification programs focus exclusively on people who purchase at least some basic manufactured foods, participation in these programs can be seen as getting people “ready to purchase” other products. The programs can generate enormous goodwill as consumers see that companies that sell fortified products are also improving the quality of consumers’ lives. By delivering such clear benefits, companies will create a climate in which consumers will be more willing to try other product innovations. After all, trust and credibility is at the heart of any consumer-company relationship. Therefore, a company’s successful participation in a fortification program can help it initiate or expand relationships and operations throughout Asia.

New Market Paradigm

For the low-income consumer, even small price increases present a tragic choice between better health and a bit of savings. Because segments of the most at-risk populations cannot take advantage of market-based solutions, many of the CIPs include novel public-private partnerships to provide special access, incentives, or pricing for the poor. These ideas are based on a concept of “dual markets” for fortified products: a self-sustaining, profit-oriented traditional marketplace, alongside a parallel “public-health market” targeting the low income or at risk. (See Figure 1.) Revenue streams from the more affluent commercial markets are invested in the new public-health market. This concept allows for investments in distribution and/or marketing networks that reach rural areas and public education projects that aim to increase awareness and demand among the poor. A number of proposed projects in the CIPs thus feature partnerships with innovative approaches to pricing and distribution for the public-health market, including:

- expanded commercial distribution to rural areas;
- product distribution via government agencies such as the Ministry of Health (MOH);
- home sales visits and face-to-face education by volunteers from nongovernment organizations (NGOs); and
- free public distribution programs and targeted subsidies.

The dual-market approach offers a “win-win” for all involved. Poverty-focused partnerships among companies, government agencies, and NGOs can expand the marketplace and increase the total sum of consumers. As producers increase volume, unit costs decline. Marketers and distributors can introduce a new class of consumer to their products. Governments can open efficient new channels to serve the poor and at-risk. NGOs and other civil society organizations focused on health, education, or development can establish new programs and find sources of incentive and support for their volunteers on the ground. As low-income and at-risk individuals become everyday consumers, all sectors benefit.

Public-Private Partnerships for Program Success and Market Development

To be successful, fortification programs must ultimately be sustainable and market driven. When donor subsidies end, governments and private industries must be prepared to pick up the slack. But government priorities change. Nutrition may be important today, but other emergencies may take precedence in the future. In the face of these realities, it is critical that the markets and the private sector play long-term roles. While philanthropic foundations can sometimes substitute for the public sector in helping to build capacity for governance, in the long run it is the public sector's job to provide the needed governance mechanisms—regulation, standard setting, and public education that pave the way for private-sector investment.
The five CIPs outlined in this report, which carry the endorsements of their respective governments, provide strong evidence of commitment to allocating the necessary public resources. What remains is to augment that commitment with a focused mix of international investments to ensure that these fortification projects are equipped to achieve their important goals and become self-sustaining over time.
Chapter 1

Process
Building capacity, consensus, and collaboration

In February 2000, the Asian Development Bank (ADB) convened the Manila Forum 2000\(^8\) to accelerate national efforts to fortify common basic foods with essential micronutrients in Asia and the Pacific. Multidisciplinary delegations from eight countries in the region gathered to learn from one another’s experiences, identify needs for technical assistance, and test the need for regional and international support. The Forum suggested the need for multisector national teams to prepare investment programs, identify priority actions to create an enabling environment for fortification, and develop market mechanisms that could be self-sustaining over time. Regional consensus on fortification goals and strategies was recognized as the precursor to concerted national action.

Building directly on the Manila Forum, ADB worked in consultation with public- and private-sector leaders in the region to launch the Regional Initiative to Eliminate Micronutrient Malnutrition through Public-Private Partnership. This initiative was enabled through cofinancing by the Government of Japan, the Denmark International Development Agency, and the International Life Sciences Institute. It has endeavored to identify regional needs, build regional and national capacity, identify fortification priorities, develop appropriate projects, and craft Country Investment Plans (CIPs) to attract the seed investments necessary to develop sustainable fortification markets that reach populations in need.

Five countries from the Manila Forum—India, Indonesia, People’s Republic of China, Thailand, and Viet Nam—were joined by a sixth, Pakistan, in forming Country Teams that include government, industry, academia, and civic-sector organizations. The ADB asked the US-based Keystone Center to assemble an international team of specialists in relevant fields, including private- and public-sector investment, health and nutrition economics, communications, trade and legislation, quality assurance and food control, health surveillance, food technology, and consensus building—to assist the Country Teams with national planning and advocacy, design and lead regional workshops, and guide the development of the CIPs. (See Annex A for a complete list of project participants.)

The initiative used issue-specific workshops to promote the sharing of information and best practices, cultivate skills in investment planning, identify shared resource needs and strategic opportunities, and build skills in investment planning.\(^9\) (See Figure 2 for the timeline of key meetings and workshops.) In addition, ADB and the United Nations Children’s Fund organized these countries’ participation in the PRC’s celebration of reaching almost universal salt iodization, and the Asian nations learned valuable lessons about scaling up their own salt programs to reduce iodine deficiency disorders.

---

\(^{8}\) ADB, Manila Forum 2000: Strategies to Fortify Essential Foods in Asia and the Pacific (Manila: ADB, 2002). A consensus statement signed by eight countries from Asia and the Pacific region declared readiness to work toward the regional adoption of processed foods that are compatible with the dietary needs of the poor and with internationally agreed-upon standards for the fortification, regulation, and trade of food products.

\(^{9}\) The Government of India participated in these workshops, but reserved its official opinion regarding the consensus statements.
The thorough consultative and technical assessment process undertaken by these parties has positioned the Country Teams for the successful implementation of the projects set forth in the CIPs, pending an appropriate mix of investments. Moreover, the process as executed has allowed for a regional perspective on problems that are sometimes perceived by individual countries to be unique to them. Understanding these crosscutting issues enabled the Country Teams to share experiences and discuss the possibility of regional efforts to overcome barriers to success.

The process of developing the CIPs emphasized four key elements.

1. **National ownership** of the CIPs by the Country Teams and their governments
2. **Collaboration among the public, private, and civic sectors** to gain the endorsement of industry, key national institutions, and NGOs, as well as the relevant government ministries
3. **Implementation**, each CIP presents realistic projects with a likelihood of success
4. **Regional capacity building and decision making**, common opportunities and challenges could be addressed with regional solutions

The remainder of this chapter provides detail on these four process elements.

**National Ownership**

While this project, like many development efforts, relied on consultants for technical assistance, the Country Teams themselves gathered the data, undertook the analysis, identified the priorities, and developed the CIPs. Capacity building of multisectoral national fortification teams and national ownership of the CIPs are at the heart of this project. Therefore, although the CIPs do not always follow the same format, they all reflect a national perception of opportunities and realities. For example:

- The Thailand CIP builds on a successful history of public-private collaboration to propose an official Nutrition Seal—a national, collaborative system to develop, market, assure the quality of, and monitor fortified foods.
- Closely knitted with civil society, the Viet Nam CIP proposes novel partnerships with NGOs that provide powerful new channels to government and industry leaders as well as to consumers.
- To fortify wheat flour in the poor northwestern provinces of the country, the PRC's CIP grapples with the balance between vast potential health benefits and the realities of small community producers.
- Indonesia's CIP considers options to protect domestic millers that comply with mandatory flour regulations from a flood of nonfortified and less-expensive flour.
- The Pakistan CIP addresses complex governance issues and makes an innovative, albeit embryonic, proposal to deal with them in the context of a wheat fortification plan.

**Collaboration Among the Public, Private, and Civic Sectors**

At the project's Inception Meeting in August 2001, Country Teams reflecting the breadth of public, private, and civic society began a year-long commitment to conduct a national situation analysis, review data, consider policy and regulatory reforms, and undertake the financial analysis and initiate the political mobilization necessary to both write a CIP and make it a reality. In many cases, the formation and operation of these Country Teams evolved new relationships among government, industry, and academia. For example:

- In the PRC, the Public Nutrition Center of the State Planning and Development Commission began a serious dialogue with the wheat milling industry.
- The Viet Nam Women's Union (VWU) was brought into direct discussions on nutrition issues with the national Government and public health agencies of that country.
- The Indonesian wheat millers' association worked with Indonesian government agencies to develop a national marketing campaign.
- In Thailand, the Ministry of Public Health and Mahidol University opened a dialogue with the wheat milling and fish sauce industry associations, as well as specific companies.
For the first time, an independent group of Pakistani economists provided an economic analysis of fortification for a range of government ministries, including those governing food and agriculture, health, and planning.

Implementation

The multisectoral collaborative approach enabled a focus on implementation. The integral involvement of industry made it possible to consider thoughtfully how each program would actually be developed, what timeline for action was possible, and how success would be measured. Discussions among a variety of stakeholders—which is still ongoing—yielded pragmatic, strategic, and sometimes opportunistic decisions. For example:

- The Vietnamese team concluded that oil and sugar fortification, while initially considered promising, failed the benefit-cost test under current conditions. (See Annex E for a complete discussion of the benefit-cost test.)
- The Pakistani team came to the reasonable conclusion that fortification of flour from chakki mills—small stone mills exclusively serving local markets—was simply not feasible, at least in the next 5 years.
- Testing by the Thai team concluded that vitamin A could not be cost-effectively added to dried broken rice, a promising product that reaches young children from 6 to 36 months. However, they found that the project would be cost-effective and feasible if four other vitamins and minerals vital to child growth were added.
- The Chinese team concluded that flour fortification should focus on specific regional markets prior to expanding to the national scale and that mandatory legislation could not be considered until the final stages of the 10-year plan.
- Indonesia concluded that, while palm oil fortification with vitamin A is uniquely appropriate for a nation with 50% VAD prevalence and one of the world’s largest crude palm oil industries, product development and advocacy should precede any major investment.

Regional Capacity Building and Decision Making

As noted previously, ADB convened three regional, issue-specific, capacity-building workshops in Asia between August 2001 and October 2002—one each in Bangkok, Manila, and Singapore. At these workshops, the multidisciplinary Country Teams worked with ADB experts, a supporting team of technical consultants and facilitators from The Keystone Center, and several invited specialists and strategists to share information, build technical and analytical skills, and chart a course for the region. From these three workshops came consensus statements covering five general topic areas that outline common ground, endorse provisional fortification guidelines, make technical recommendations, and define regional and national actions necessary to accelerate fortification in Asia. The five topics are:

- legislation, regulation, and trade;
- quality assurance, food control, and nutrition surveillance;
- wheat flour and cooking oil fortification;
- regional cooperation and capacity building to support food fortification; and
- linking the expansion of processed complementary foods to public health services that optimize child growth for children under the age of 2.

Participants’ key agreements on these topics are summarized in the following sections. Annex B contains the complete consensus statements.

The consensus statements emerged from a shared vision of micronutrient malnutrition as a serious public health problem and fortification as a key solution. The following are from the statement of the Bangkok Regional Workshop on Trade, Regulation, Surveillance, and Quality Assurance of Fortified Food Products:

- Micronutrient deficiencies are causing serious damage to social and economic development through poorer pregnancy outcomes, impaired cognition (especially in young children), reduced work capacity, and increased morbidity and mortality from infectious diseases.
- Food fortification offers an effective, low-cost, and sustainable approach to reducing the prevalence of these deficiencies.
Collaboration between government, private sector, and civil society is the key to sustained and effective implementation of food fortification to reduce micronutrient deficiencies. Mechanisms should be defined collaboratively that pass all costs of fortification programs to the consumer as soon as feasible.

While additional research and development is needed to better define optimal fortification approaches, it is also recognized that nutrition delayed is equivalent to nutrition denied, and therefore countries of the region should move forward consistent with the current evidence and scientific consensus.

Regional Policy Consensus on Legislation, Regulation, and Trade

While open and clear communication with the private sector is critical, the Country Teams focused on the lead role of governments in establishing a trusting and enabling environment for food fortification. The consensus statements from the Bangkok and Manila workshops affirmed the following:

- National food laws and regulations should be reviewed and amended to ensure that they support and enable the addition of all essential micronutrients to appropriate food products.
- Public policies and regulations constraining or impeding investment in food fortification should be reviewed and amended.
- Appropriate intergovernmental and/or institutional mechanisms should be established to implement effective policy in concert with partners in industry and civil society.
- Countries should enhance current regulatory frameworks and build capacity to implement food control and enforcement functions in a systematic, transparent, and fair manner.
- National customs protocols and trade regulations should be revised or enacted to facilitate the import and export of certified and safe fortified foods.
- Taxes and duties on inputs to fortification as well as taxes on domestically produced fortified food products should be minimized in the case of mandatory fortification programs.

Consensus on Quality Assurance, Food Control, and Nutrition Surveillance

Workshop participants recognized the need to build national and regional quality assurance capacity to ensure that food fortification efforts are effective, safe, and sustainable. Transparent food control monitoring and enforcement were recognized as essential.

Participants from the five countries urged their governments to initiate programs to empower inspectors and technicians. They felt this should include a range of incentives for food control personnel, as well as penalties to enable personnel to enforce laws fairly and transparently. A combination of improved recruitment, training, protocol development, and increased penalties should be implemented, with a view toward zero tolerance of corruption in the inspection force and in industry.

The technical consensus focused on regional cooperation and the harmonization of quality assurance and nutrition surveillance methodologies. Participants from government and industry agreed on food control and enforcement approaches that rely not only on punitive measures but also on positive incentives to the private sector for consistent performance meeting fortification quality standards. Representatives of government health departments and participants from academia and research institutions agreed on common regional protocols for nutrition monitoring, surveillance sampling frames, and biochemical indicators to produce reliable and regionally equivalent data on population micronutrient status. These guidelines for food control and nutrition surveillance provided a foundation for planning and budgeting these critical public functions in the CIPs.

Regional Consensus on Flour and Cooking Oil Fortification

Technical workshops focusing on the fortification of flour and oil set out a vision that all flour and edible

---

10 Indonesia, Pakistan, PRC, Thailand, and Viet Nam. India reserved its opinion.
oils used in the preparation of staple foods, such as leavened and unleavened breads, noodles, pastas, biscuits, and other flour products, and consumed by at-risk populations in the region, should be fortified. Participants urged their governments to review regulations and policies that might impede the fortification of these products and recommended appropriate mechanisms for government cost sharing until such time as the costs of fortification can be fully passed on to the consumer. Perhaps most significant, the participants from government and private industry agreed on regional guidelines to provide a starting point for the consideration of flour fortification. The recommended basic fortification package for flour includes iron and folic acid, along with several other micronutrients commonly added to flour. (See Table 4.)

<table>
<thead>
<tr>
<th>TABLE 4: Basic Recommended Fortification Package for Flour</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>White Flour</strong> (PPM)</td>
</tr>
<tr>
<td>Folic Acid 2.0</td>
</tr>
<tr>
<td>Iron 60.0</td>
</tr>
<tr>
<td>Riboflavin 4.0</td>
</tr>
<tr>
<td>Thiamin 2.5</td>
</tr>
<tr>
<td>Zinc 30.0</td>
</tr>
</tbody>
</table>

Participants also recommended that, where a public health need is demonstrated, niacin, vitamin B₆, vitamin B₁₂, calcium, and vitamin A be added at 25% of the recommended daily allowance (RDA). Participants from the private sector affirmed that fortification at these levels is technically feasible and that there are no capacity constraints within the industry. Similar guidelines were established for oil fortification with vitamins A and D.

Need for Regional Cooperation and Capacity Building to Support Food Fortification

The Country Teams acknowledged that resource and skill constraints could hinder the implementation of their consensus recommendations and the achievement of their shared vision. Participants recognized that the cost effectiveness and efficiency of cooperative arrangements among regional institutions would be critical to overcoming these barriers. The Country Teams’ consensus recommendations include the development of regional technical capacity, including:

- a regional food control and quality assurance framework to accredit laboratories, develop and train inspectors and analysts, and promote fair and transparent regional trade;
- a regionwide framework for nutrition surveillance to develop common guidelines and offer an adequately staffed regional reference laboratory; and
- “centers of technical excellence” to undertake operational research and product development.

A crucial area for regional cooperation and investment is in the production, distribution, and quality assurance of fortificant and premix. The five CIPs describe an expanding and potentially huge market for vitamin and mineral fortificants—more than half a billion dollars over 10 years for the 10 proposed wheat, oil, and condiment fortification programs. In fact, the fortificant mixes themselves account for about 70% of all projected public- and private-sector fortification costs. (Table 5 shows the percentage for each of the 10 projects individually.) Securing consistent access to the least-cost, quality-assured fortificant was a priority topic at a number of workshops. Several consensus statements recommended that ADB and other relevant institutions explore investment in an expanding regional production complex—as well as strengthen

---

11 The basic recommended fortification package for flour was negotiated at the Regional Workshop on Flour and Cooking Oil Fortification. The Consensus Statement which articulates the package can be found in Annex B.
regional and national public institutions to create an enabling and transparent business environment and a quality product.

Regional Consensus on Complementary Feeding

A workshop organized in collaboration with the International Life Sciences Institute (based in Washington, DC) and Mahidol University (based in Salaya, Thailand) focused on the critical need to improve the nutritional status of children from 6- to 24-months. While infants in developing countries start growth at average levels, between 6 and 24 months the deterioration of nutrition indicators is severe. It was recognized that children in this age group have the highest rates of micronutrient deficiency of any risk group. In addition to increasing the risk of death, micronutrient deficiency during these critical months reduces cognitive development and is clearly associated with lower performance in school and the workplace. In recognition of the special needs of these children, workshop participants urged governments to:

- establish national goals for the production and distribution of affordable complementary foods, and
- integrate fortified complementary foods into public health, development, and child nutrition programs.

Regional Public Goods for Health and Human Development

Regional public goods (RPGs) are increasingly seen as a viable option that developing countries and the donor community should use to address compelling problems with transnational scope. Infectious diseases that disrespect national borders, disputes over trade and fairness in international business practice, harmonizing regulations that govern the exchange of health goods and services (fortified foods and essential drugs are the most compelling examples), and establishing fair and consistent prices for essential goods at regional level, all are transboundary development challenges that call for solutions at a regional level.

RPGs respond to market failures, common among health-related policies and interventions, where investment particularly by the private sector may be constrained by disproportionate benefits accruing to the poor and lowered profits that are expected. RPGs stipulate the provision on nonrival benefits so that one country benefiting does not provide obstacles to another also benefiting.

### TABLE 5: Cost of Fortificant Mix and Recurring Costs as a Percentage of Ten Year Projected Costs

<table>
<thead>
<tr>
<th>Projected Total Cost of Project Over Ten Years ($)</th>
<th>Cost of Fortificant Mix Over Ten Years ($)</th>
<th>Fortificant as a Percentage of Total Cost (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indonesia</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wheat Flour</td>
<td>20,586,000</td>
<td>14,350,000</td>
</tr>
<tr>
<td>Cooking Oil</td>
<td>60,372,000</td>
<td>48,490,421</td>
</tr>
<tr>
<td>Pakistan</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cooking Oil</td>
<td>35,833,000</td>
<td>31,107,220</td>
</tr>
<tr>
<td>Wheat Flour</td>
<td>165,594,000</td>
<td>137,415,000</td>
</tr>
<tr>
<td>PRC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wheat Flour</td>
<td>184,125,000</td>
<td>101,081,100</td>
</tr>
<tr>
<td>Soy Sauce</td>
<td>240,238,000</td>
<td>198,030,000</td>
</tr>
<tr>
<td>Thailand</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fish Sauce</td>
<td>24,463,000</td>
<td>22,915,000</td>
</tr>
<tr>
<td>Wheat Flour</td>
<td>2,759,000</td>
<td>1,925,000</td>
</tr>
<tr>
<td>Viet Nam</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fish Sauce</td>
<td>21,740,000</td>
<td>15,450,000</td>
</tr>
<tr>
<td>Wheat Flour</td>
<td>3,815,000</td>
<td>2,135,000</td>
</tr>
<tr>
<td>Total</td>
<td>759,525,000</td>
<td>572,898,741</td>
</tr>
</tbody>
</table>
Countries that do not pay for the RPG are not excluded from its benefits (i.e., benefits from an RPG are not held by a selective “club” of stakeholders, and are instead received by all parties). Also, RPGs reduce overall transaction costs for delivering benefits by spreading responsibility and building regional institutions that will assume the burden of sustained capacity building over the long term.

**Trade and Health**

The benefits of trade liberalization are often questioned, not least because of the impasse at the Cancun talks (September 2003) that stymied progress in reducing subsidies from the developed countries to agricultural products, among other areas. Nevertheless, all countries are permeable to the influences of globalization, and two essential commodities needed by the poor—processed (fortified) foods and medicines essential for delivery of primary health care—can benefit from trade because international standards of quality and transparent pricing and product labeling are required by the World Trade Organization agreements.

**Creating an ASEAN-PRC Alliance for Nutritionally Fortified Foods**

The recommended place to start is the influential Association of Southeast Asian Nations (ASEAN), an economic bloc of 10 countries that has recently signed a free-trade agreement with the PRC that could very well facilitate fair pricing, high quality, and universal access for commonly consumed commodities like processed foods and essential drugs. This could well spark an Asia-wide adoption of trade practices that will contribute to nutrition security and medical protection against fatal diseases for poor Asian families, especially their children.

Based in part on the findings of this study, food fortification is now recognized as an essential element of national food policies in Asian and Pacific countries to ensure nutrition security for all their citizens. Asia is poised to apply food science and technology in the food industry and make strides in solving the lingering micronutrient deficiencies (vitamins and trace minerals) that impede human development (and indirectly economic development) on a massive scale. A mature food industry in Asia will soon be prepared to deliver micronutrients through fortified foods at the population level, substantially reduce maternal and young child deaths, and also help children achieve optimal physical growth and mental development at very low cost. The technical costs of production are not prohibitive, as this multicountry study demonstrates.

ADB has shown regional leadership in implementing fortification programs in Central Asia and helping mainland Asian countries define, through country investment plans, a niche for the food industry to improve the health of the poor, as well as the educability of their children, through the fortification of essential, commonly consumed foods. A variety of foods can deliver iron and reduce anemia (wheat flour, condiments such as soy and fish sauce and MSG), reduce vitamin A deficiency (cooking oils, margarine, sugar), reduce iodine (salt) and zinc deficiencies (wheat flour), and all forms of malnutrition with infants and very young children (through multiple micronutrient-enriched complementary foods).

The ASEAN-PRC free trade agreement offers an opportunity to move fortified foods in major production systems throughout this region, and the proposed regional initiative would promote the harmonization of standards to effect rapid adoption of fortified staples and to tap the power of regional trade to induce competition and institutionalize structural reform packages that will raise the credibility of ASEAN and PRC as formidable partners in global food trade. Donors, working with the ASEAN Secretariat, should examine how the Asian region can create common approaches to regulation, quality assurance and food control systems, and trade. Harmonization of all regulatory and trade protocols in the 11 nations with the Codex Alimentarius standards for food safety and product labeling, as well as the WTO agreements with its member states, should be the goal by 2005.
Chapter 2

Methodology
An analytical framework for the country investment plans

The moral imperative to address the overwhelming and needless human tragedy caused by micronutrient malnutrition is clear. However, the successful implementation of food fortification to reduce micronutrient malnutrition rests with a more pragmatic imperative: attracting the necessary investment in public and private capacity by making a clear and compelling business and investment case. The Country Investment Plans are an attempt to do this. The CIPs are specific, concrete, and quantified. Each of the CIPs includes the following elements:

- A public health situation analysis that includes prevalences of micronutrient malnutrition and their consequences as well as a review of existing policies, programs, and strategies, and their strengths and weaknesses;
- Proposed fortified food vehicles selected on the basis of industrial feasibility, commercial potential, projected consumption by the poor, and access and affordability to low-income consumers;
- A defined production-sector strategy outlining implementation needs, capital investments, and recurring costs;
- An elaboration of government commitments and responsibilities as well as capacity needs, including projected budgets for regulatory, food control, and nutrition monitoring and surveillance functions;
- Best estimates for coverage and protection of low-income and at-risk consumers based on consumption, stability, and industry coverage;
- Projections for the reduction in national prevalence of VAD and IDA, and estimated impacts of the addition of folic acid; and
- A financial summary reviewing benefits and costs on annual and 10-year bases.

The CIPs represent a needed first effort to systematically quantify the inputs and outputs of food fortification programs. They include benefit-cost ratios and internal rates of return for each proposed food vehicle. The analysis undertaken to arrive at these figures is inchoate and complex and crosses many disciplines. While detailed documentation is included in Annexes C, D, and E, a summary explanation of the methodology used is provided in this chapter.

Need for a New Framework for Analysis

Micronutrient malnutrition has received significant attention not only because of the harsh human toll, but also because of the high economic costs to society and the low costs of vitamins and minerals. A robust body of literature focuses on the financial burden imposed by widespread micronutrient deficiencies—including increased morbidity and mortality, decreased cognitive development, higher health care utilization, and depressed productivity. However, few models have projected the concrete costs of the inputs needed to implement fortification, and fewer still have realistically estimated the potential benefits. For the CIPs, an analytical framework to estimate benefits and costs was developed. This involved gathering evidence, defining critical gaps, and ultimately making educated assumptions based on the best available information. This framework is proposed as a practical and immediate tool to identify public health and development priorities, make policy decisions, and take reasonable business risks.
Determining the Costs of Micronutrient Malnutrition

In the CIPs, the national costs of micronutrient malnutrition were determined using an adapted version of PROFILES,12 a widely used tool for analysis and advocacy related to nutrition interventions. This was augmented by a subsequent analysis by the developers of this model.13 PROFILES is based on assumptions established from the analysis of a large number of scientific studies, and reflects the scientific consensus on the devastating human, social, and economic consequences of micronutrient malnutrition. Some of the consequences are as follows:

- The relative risk of mortality among children from 6- to 60-months old with VAD is 1.75. The economic cost of deaths arising from VAD is then measured by the foregone wages earned.14
- Children from 6- to 60-months old with VAD suffer higher rates of morbidity. Their relative risk of clinic attendance is 1.19 and hospitalization is 1.84. The increased economic burden is based on national rates of utilization and costs for clinic and hospital visits.
- As a consequence of anemia, cognitive development is impaired. Intelligence measures in children generally drop by 7–8 IQ points (i.e., 0.5 standard deviation)—a change associated with a 4% loss of future earnings power. Losses are projected at the average national hourly wage.
- Anemic adults engaged in heavy manual labor are 12% less productive than adults without anemia. For blue-collar workers the deficit is 1%. The impact for workers in less physically demanding labor is not measured.

The original PROFILES analysis included no component to measure the impact of folic acid deficiency (FAD). For this project, a preliminary approach was developed based on reports of the United States’ Centers for Disease Control and the Canadian Public Health Service15 and an analysis by Tice, et al., published in The Journal of the American Medical Association.16 This preliminary model, which has not been tested outside the CIP project, is based on the US experience, in which an added daily intake of approximately 100 micrograms folic acid has provided the following benefits:

- Neural tube defects (NTDs) are reduced by up to 30%. When national data was too sparse, a rate of 4 NTD births per 10,000 was applied.17 Relative risk of death was taken from country data; where such data were not available, NTD children are presumed to die. Their lives are measured by 30 years of discounted earnings at the average wage.
- CHD events are reduced by up to 13% for men and 8% for women, with comparable reductions in CHD mortality. The costs of treating these are modeled using national healthcare utilization and cost data.
- A reduction in CHD events in turn results in a corresponding and proportionate reduction in the number of deaths attributable to CHD. While deaths averted were calculated, the model assumes that CHD events occur after an individual’s primary earning years. Therefore, no economic consequences were calculated.

These practical assumptions provide the framework for calculating national economic benefits emerging from reduced rates of VAD, IDA, and FAD. The results are based on a number of specific relational variables in the five countries, including prevalence rates among risk groups, demographic data, health care

---

14 This is estimated by the discounted earnings (at the average wage) up to age 50. The use of shortened productive years is to take into account that not all survive up to retirement age. The estimate also takes into account the employment rate.
17 Personal communication with Dr. Godfrey Oakley, US Center for Disease Control and Prevention and Rollins School of Public Health at Emory University, based on his global research and field work in the PRC.
costs and utilization rates, as well as a range of wage and labor statistics and other economic data. For example, the global assumption for the impact of anemia prevalence on productivity is qualified by the national situation, including the number of women in the labor force, the proportion in heavy manual and blue-collar labor, and the average annual wage. In this model, anemia in a full-time mother or an office worker presents no cost to society.

Each CIP proposes specific food vehicles to be fortified at specific levels and estimates the total number of metric tons (MT) fortified of each. Between 48% and 95% of the project costs are composed simply of the cost of the vitamins and minerals or the micronutrient mix that is actually added to the food vehicle.

However, successful implementation depends on a series of significant investments in key public- and private-sector capabilities. These capabilities include the following.

- advocacy, capacity building, and empowerment of government agencies through legislation and regulations to establish a positive market environment;
- plant improvements, equipment purchases, and ongoing quality control and other recurring operational costs (A common basis for this analysis emerged from the Regional Workshop on Flour and Cooking Oil Fortification.);
- food regulatory and inspection activities (For this item, budgets are based on the estimated number of production sites and sampling frequency to establish operational, analytical, and management costs. In some cases, the CIPs propose capital investment in building public laboratories. In other cases, the analysis is outsourced to the private sector.);
- nutrition monitoring and biological evaluation (In many cases, these costs are based on consensus methodologies developed at the Regional Workshop on Trade, Regulation, Surveillance, and Quality Assurance of Fortified Food Products); and
- social marketing (National leadership advocacy and public communication were seen as essential to establishing a foundation of consumer support and awareness.).

See Table 7, at the beginning of Chapter 3, for a summary of the 10-year costs of the food fortification projects proposed in the CIPs.

**Projecting the Benefits of Fortification**

While the cost side of the equation may entail the fortification of 100% of a particular food, the benefit is determined by the amount of fortified food consumed by at-risk populations. A mix of national consumption surveys and industry data, along with the USDA Foreign Agricultural Service's information and the FAO’s Food Balance Sheets, was used to project the potential consumption of fortified foods, with an emphasis on consumption by low-income populations. To determine the projections for added micronutrient intake, the estimated consumption of fortified food was essentially multiplied by the level of fortification and other relevant factors (e.g., vitamin stability, and products from small producers and the informal production sector, which are not considered “fortifiable”). Thus, the analysis arrived at milligrams or micrograms of each micronutrient that would be added to the daily intake of foods consumed by low-income and at-risk groups. However, the benefits of fortification are not measured by added micronutrients but by real reductions in the prevalence of micronutrient deficiencies and the subsequent functional benefits in health and performance.

Prevalence reduction thus drives the benefit calculations. In the case of fish and soy sauce fortification proposed respectively by the Viet Nam and PRC CIPs, the projections for prevalence reduction were based on the results of large-scale effectiveness trials. In the other CIPs, however, the uncharted leap from estimates of added micronutrient intake to projections for reductions in prevalence was based on a methodology developed for this project. This methodology, which is described in Annex C, is based on a review of the best available evidence.\(^{18}\)

- Projected reductions in VAD are based on studies documenting consumption, added micronutrient delivery, and changes in

\(^{18}\) For a full elaboration of the proposed approaches to projecting prevalence reduction, please see Annex C.
prevalence after national sugar fortification in Guatemala and large-scale MSG fortification market trials in Indonesia.

- Reductions in NTDs and CHD are based on changes measured in the US and Canadian populations after national flour fortification increased the average per capita intake of folic acid by 100 micrograms per day.19
- Since data from iron fortification programs are limited, the projected reductions in iron deficiency anemia prevalence are based on a published meta-analysis reviewing the impact of 35 supplementation trials in Africa, Asia, and Latin America.20

The CIPs project reductions in the national prevalence of IDA or VAD for each of the 14 proposed fortification projects. The projected reductions range from 1% to more than 30%. Table 6 outlines the expected 10-year benefits of these improved national prevalences. The same assumptions and calculations used to estimate the prefortification costs of micronutrient deficiency are used to measure the remaining postfortification losses. As illustrated in Table 6, this results in specific projections for benefits, or costs to society averted. Having calculated specific benefits and costs, annual and 10-year benefit-cost ratios and internal rates of return can be specified.22

**Special Note on Complementary Foods**

Improving the physical and mental growth of children under age 2 in developing Asia is a great challenge to public health programs and to private sector applications of food science and technology for young children, including the processed food industry. The enormous problems of stunting and multiple micronutrient deficiencies in very early childhood are...

---

**TABLE 6: Projected Ten-Year Benefits of Projects Proposed in the CIPs**

<table>
<thead>
<tr>
<th>Project Vehicle</th>
<th>Micronutrient</th>
<th>Deaths Averted</th>
<th>Health Care Costs Saved ($ ’000)</th>
<th>Productivity Saved/ Gained ($ ’000)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Indonesia</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wheat Flour</td>
<td>Iron and Folic Acid</td>
<td>111</td>
<td>924</td>
<td>103,210</td>
</tr>
<tr>
<td>Oil</td>
<td>Vitamin A</td>
<td>44</td>
<td>555,80225</td>
<td>110,575</td>
</tr>
<tr>
<td><strong>Pakistan</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wheat Flour</td>
<td>Iron</td>
<td>38</td>
<td>9,603</td>
<td>328,259</td>
</tr>
<tr>
<td>Oil</td>
<td>Vitamin A</td>
<td>42</td>
<td>18,234</td>
<td>120,026</td>
</tr>
<tr>
<td><strong>PRC</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Soy Sauce</td>
<td>Iron</td>
<td>0.5</td>
<td>5,195</td>
<td>338,151</td>
</tr>
<tr>
<td>Wheat Flour</td>
<td>Iron and Folic Acid</td>
<td>32</td>
<td>5,195</td>
<td>338,151</td>
</tr>
<tr>
<td><strong>Thailand</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wheat Flour</td>
<td>Iron and Folic Acid</td>
<td>5</td>
<td>384</td>
<td>13,019</td>
</tr>
<tr>
<td>Fish Sauce</td>
<td>Iron</td>
<td>0.014</td>
<td></td>
<td>160,725</td>
</tr>
<tr>
<td><strong>Viet Nam</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fish Sauce</td>
<td>Iron</td>
<td>0.8</td>
<td></td>
<td>257,825</td>
</tr>
<tr>
<td>Wheat Flour</td>
<td>Iron and Folic Acid</td>
<td>8</td>
<td>2,216</td>
<td>34,889</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td>281.3</td>
<td>592,358</td>
<td>3,916,735</td>
</tr>
</tbody>
</table>

---


21 High returns relative to other countries are due to the highest reported VAD prevalence in children in the region (over 50%) as well as the structure and costs of health care utilization. This figure remains under review.

22 These 10-year projections take into account the time lag between the consumption of fortified foods and functional benefits. For example, it is assumed that added iron received via fortification will not impact anemia prevalence until 12 months after regular consumption of fortified foods begin.
not being adequately addressed within the economic means and parenting skills of poor Asian families, and Asian governments are not generally assisting the development of a complementary foods industry. Where complementary foods are available, they are of the “boutique” variety intended for, and priced within the means of, the middle and upper classes. Thus, experience with complementary foods for the poor is very limited in Asia. Moreover, the elimination of physical and mental deficits in very young Asian children also involves a strong shift in public health systems, which currently focus on micronutrient supplement programs rather than integrated growth scenarios. Several successful interventions, listed below, provide the necessary and sufficient conditions for poor children to grow normally and protect their health and learning potential.

- promoting exclusive breastfeeding for at least 6 months according to the Code;\(^{23}\)
- public education (formal and informal media) and health promoters with responsibility for community outreach which conduct home visits working with primary caregivers to optimize infant feeding practices and domestic hygiene that will reduce diarrhea prevalence and growth faltering in very young children;
- integrated breastfeeding and semisolid complementary foods introduced at 6 months and monitored by community programs that chart the growth and development milestones of children; and
- introduction of food-based programs for young child feeding, including home-based and industrially processed complementary foods, with strengthened social marketing, regulatory and quality-assurance systems at national and subnational levels of government. Affordability and food safety/quality should be the instruments of effective demand and consumer choice.

It is obvious that the contribution of processed complementary foods must be considered in this context, and in any case should not be regarded as the “magic bullet” that will reverse physical and mental growth faltering in young Asian children. But the potential role of multiple micronutrient-fortified complementary foods should not be underestimated either, because studies on the economic losses from stunting and micronutrient deficiencies have demonstrated the high “shadow price” of the nutritional status quo and the weak impact of public health programs; because scientific reviews\(^{25}\) have shown significant shortfalls in macro- and micronutrients that young children need; and because the velocity of growth in the first 12, 18, and 24 months of life is so rapid that responsive feeding must be elastic. This is precisely where the “scaling up” of affordable processed complementary foods could make a big difference in the future learning and earning potential of children.

For all these reasons, it is premature to develop a rigorous economic benefits analysis for industrially processed complementary foods, but their inclusion in this study, and the production frontier of the Asian food industry, is warranted.

### Conservative Approaches

To prevent overly optimistic projections in the CIPs, the assumptions used are generally based on conservative interpretations of the evidence. Therefore, the projected benefits are intended to provide a floor rather than a ceiling. For example:

- The CIPs attach no dollar value to an adult life saved. Reduced maternal mortality and deaths from CHD are not quantified.
- In the CIPs, productivity loss attributed to anemia for heavy manual labor and blue-collar labor is among the lower estimates found in the literature. While the CIP model used a 1% figure for productivity loss among anemic blue-collar


\(^{24}\) Psychomotor, psychosocial, and cognitive.

workers, a recent study in the *Asian Development Review* estimates a loss of 5%. The same study estimates wage losses for heavy work at 17% while this model uses 12%. The less-conservative assumptions would have doubled the benefit-cost ratios for IDA interventions included in the CIPs.

- The estimated benefits of fortifying flour with iron are limited to populations with iron deficiency anemia. However, a number of studies indicate negative impacts on cognitive development and performance with iron deficiency, even without the onset of clinical symptoms of anemia. Iron deficiency anemia is used as a conservative standard because the functional impacts are more extensively documented and quantified and because few countries have data on the prevalence of iron deficiency as opposed to anemia. However, since it is generally thought that for every case of iron deficiency anemia there is another case of iron deficiency, this conservative standard may limit the projected benefits of iron fortification in the CIPs to half of the potential beneficiaries.

- For both anemia and VAD interventions, no benefits are attributed for the first year of fortified food consumption. Several supplementation trials have shown significant improvement in nutrition within shorter time frames. In the case of folic acid, the “time-lag” assumed for measurable impact is longer.

- The correction of anemia is complex and sets a much higher bar for impact than the correction of iron deficiency. For example, an evaluation of flour fortification in Venezuela shows little sustained impact on hemoglobin, the biochemical indicator of anemia, but a dramatic sustained drop on serum ferritin and other indicators of iron deficiency.

- Many negative impacts of micronutrient malnutrition suggested by the literature are not included in the analysis, either because consensus does not yet exist or because they were too complex to quantify within the context of the CIPs. These impacts include increased morbidity in anemic women and children, folic acid reducing the incidence of certain cancers, the impacts of VAD on pregnant women and other populations, and the synergistic effects of adding multiple micronutrients to the diet that mutually promote absorption and bioavailability.

- The projections for prevalence reduction based on effectiveness trials were conservatively discounted. For example, while large-scale effectiveness trials in the PRC with iron-fortified soy sauce showed a reduction in anemia of more than 50%, the PRC CIP projects only 30%.

Error bands widen as assumptions are multiplied by assumptions. Therefore, the specific numbers and conclusions offered in the CIPs should be viewed accordingly. However, the analytical framework provided Country Teams with a transparent and systematic tool to scan for fortification opportunities, create and compare potential fortification scenarios, and make strategic choices. In several cases, proposed fortification strategies were discarded because they showed a low or negative benefit-cost ratio. This allowed for some informed strategic choices and a focus on scenarios suggesting greater impact. Based on this analytical framework, the five CIPs offer reasonable fortification strategies with defensible benefit-cost ratios that can be used in the larger public debate (outside the nutrition community). This systematic approach will assist policy makers and investors in setting priorities among competing investment and development opportunities.

---


This chapter contains summaries of the five Country Investment Plans. The CIPs outline 10-year costs, benefits, and implementation strategies for 14 national food fortification projects. Below is a table summarizing the costs of, and requested funding amounts for, the 14 projects (Table 7). The following four sections describe more fully the thinking behind the proposed projects for the fortification of flour, fish and soy sauce, complementary foods, and oil, respectively. These sections are followed by the summarized CIPs for each of the five countries.

### Table 7: Ten-Year Costs of CIP Projects and Requested Funding Amounts

<table>
<thead>
<tr>
<th>Country and Project</th>
<th>Recurring Production Costs ($)</th>
<th>Capital and Start-Up Costs ($)</th>
<th>Food Control &amp; Biological Monitoring ($)</th>
<th>Marketing and Education ($)</th>
<th>Total ($</th>
<th>Seed Request (%)</th>
<th>Financing</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Indonesia</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wheat Flour</td>
<td>15,364,700</td>
<td>131,000</td>
<td>2,507,157</td>
<td>2,714,500</td>
<td>20,586,387</td>
<td>24</td>
<td>4,852,770</td>
</tr>
<tr>
<td>Cooking Oil</td>
<td>50,769,325</td>
<td>1,925,198</td>
<td>2,248,437</td>
<td>5,429,000</td>
<td>60,371,960</td>
<td>22</td>
<td>13,396,889</td>
</tr>
<tr>
<td>Comp. Foods</td>
<td>45,990,000</td>
<td>250,000</td>
<td>2,347,740</td>
<td>20,574,000</td>
<td>67,137,740</td>
<td>27</td>
<td>17,928,440</td>
</tr>
<tr>
<td><strong>Pakistan</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wheat Flour</td>
<td>137,043,730</td>
<td>23,824,000</td>
<td>2,689,170</td>
<td>2,036,620</td>
<td>165,593,520</td>
<td>22</td>
<td>37,006,536</td>
</tr>
<tr>
<td>Cooking Oil</td>
<td>31,107,220</td>
<td>2,689,170</td>
<td>2,036,620</td>
<td></td>
<td>35,833,010</td>
<td>22</td>
<td>7,836,512</td>
</tr>
<tr>
<td><strong>PRC</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Soy Sauce</td>
<td>213,780,000</td>
<td>5,625,000</td>
<td>4,900,000</td>
<td>15,933,000</td>
<td>240,238,000</td>
<td>1</td>
<td>3,071,000</td>
</tr>
<tr>
<td>Wheat Flour</td>
<td>101,081,100</td>
<td>54,450,000</td>
<td>2,194,000</td>
<td>26,400,000</td>
<td>184,125,100</td>
<td>5</td>
<td>8,702,000</td>
</tr>
<tr>
<td>Comp. Foods</td>
<td>3,419,600</td>
<td>160,000</td>
<td>1,943,170</td>
<td>8,800,000</td>
<td>14,322,770</td>
<td>36</td>
<td>5,162,170</td>
</tr>
<tr>
<td><strong>Thailand</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fish Sauce</td>
<td>22,926,009</td>
<td>221,084</td>
<td>1,315,625</td>
<td>24,462,718</td>
<td>5</td>
<td>1,221,952</td>
<td></td>
</tr>
<tr>
<td>Wheat Flour</td>
<td>2,053,024</td>
<td>121,600</td>
<td>199,380</td>
<td>385,313</td>
<td>2,759,317</td>
<td>18</td>
<td>490,739</td>
</tr>
<tr>
<td>Comp. Foods</td>
<td>3,229,643</td>
<td>201,680</td>
<td>365,313</td>
<td>3,796,636</td>
<td>14</td>
<td>525,614</td>
<td></td>
</tr>
<tr>
<td><strong>Viet Nam</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fish Sauce</td>
<td>15,450,000</td>
<td>884,000</td>
<td>2,163,000</td>
<td>3,243,000</td>
<td>21,740,000</td>
<td>19</td>
<td>4,089,300</td>
</tr>
<tr>
<td>Wheat Flour</td>
<td>2,448,510</td>
<td>171,700</td>
<td>695,000</td>
<td>500,000</td>
<td>3,815,210</td>
<td>18</td>
<td>669,926</td>
</tr>
<tr>
<td>Comp. Foods</td>
<td>34,626,639</td>
<td>1,230,280</td>
<td>805,000</td>
<td>6,975,434</td>
<td>43,673,535</td>
<td>15</td>
<td>6,516,161</td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td>$679,170,220</td>
<td>$88,772,778</td>
<td>$23,774,459</td>
<td>$96,308,425</td>
<td>$888,413,061</td>
<td>13%</td>
<td>$111,470,009</td>
</tr>
</tbody>
</table>

---

28 Indonesia, Pakistan, People's Republic of China, Thailand and Viet Nam.
29 These costs include the purchase and handling of fortificant premix and expendables for quality control activities.
30 This column shows the percent of the total project cost for which the CIP requests funding.
Two Environments for Flour Fortification in Asia

While all five CIPs propose strategies to implement national flour fortification, the three countries that are members of the Association of Southeast Asian Nations (ASEAN)—Indonesia, Thailand, and Viet Nam—present very different opportunities and challenges for flour fortification than do the PRC and the countries of the South Asian Association for Regional Cooperation (SAARC), such as Pakistan. In Pakistan and the PRC, wheat products are traditional staple foods widely consumed by the poor. In the ASEAN countries, rice remains the basic staple, and the consumption of flour products is relatively new.

Flour Fortification in the ASEAN Countries

In Indonesia, Thailand, and Viet Nam, a relatively narrow segment of the population—typically the urban and more affluent—consume noodles, breads, and other flour products. But this segment is growing very quickly. For example, Viet Nam has seen national flour consumption rise more than tenfold since 1996. Since the market for flour products in these countries is relatively new, the milling industry is fairly modern and centralized. In fact, some of the world’s largest mills and milling companies are in this part of Asia. These facilities already have sophisticated production and quality assurance processes, and several currently add micro-ingredients as flour “improvers.” As shown in Table 8, the capital and operational costs of adapting these plants for fortification, and the costs of government food control, are quite low. Likewise, government regulation and monitoring of these centralized fortification facilities is quite feasible and relatively simple.

The procurement of micronutrient mix is the major financing need in Indonesia, Thailand, and Viet Nam. Depending on the mix of vitamins and minerals, the incremental increase in the cost of the flour is estimated from $0.35 to $1.10 per metric ton FOB or “free on board.” This represents less than 1% of the current international cost of wheat. While this appears to be an invisible price increment, absorbing the recurring cost may be a challenge.

As illustrated in Table 9, while the cost of premix per metric ton is low, the purchase represents a significant annual expense from a national perspective. Moreover, since the international price is set in US dollars, the local price of imported vitamins and minerals fluctuates—and has soared since the 1997 decline of Asian currencies. The cost is further exacerbated by import duties ranging from 12% to 33% in these three countries. Advocacy to lower and/or abolish these tariffs is ongoing. It should be noted that, in Thailand, duties on premix were dropped from 31% to 1% to support a voluntary noodle fortification program.

The competitive situation is also a potential barrier. As the price of noodles and bread rises, companies fear losing consumers and market share to rice—a traditional, less expensive, and domestically produced staple. In addition to altering the domestic market via this substitution effect, a small price rise could affect the competitive balance between

| TABLE 8: Estimated Annual Costs of Equipment, Plant Improvements, and Operations (not including fortificant premix) |
|---|---|---|
|  | Indonesia ($) | Thailand ($) | Viet Nam ($) |
|  | 5 mills  | 8 mills  | 16 mills |
| Ten-Year Depreciated Cost of Equipment | 13,100 | 12,160 | 17,090 |
| Administration and Overhead (calculated as 3% of the premix cost) | 43,050 | 5,511 | 6,405 |
| Labor, Quality Assurance | 45,320 | 24,010 | 26,946 |
| Annual Costs | 101,470 | 41,681 | 50,441 |

31 The number of mills in each case are those that supply essentially 100% of national flour consumption.

32 “Free on board” in this case refers to the cost of the flour at the plant, before shipping, duties, tariffs, and so forth.
TABLE 9: Estimated Annual Costs of Two Fortificant Premixes
(not including tariffs)

<table>
<thead>
<tr>
<th></th>
<th>Indonesia ($)</th>
<th>Thailand ($)</th>
<th>Viet Nam ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>60 ppm Iron &amp; 2 ppm</td>
<td>1,085,000</td>
<td>192,500</td>
<td>213,500</td>
</tr>
<tr>
<td>Folic Acid @ $0.35/MT Flour</td>
<td>3,410,000</td>
<td>605,000</td>
<td>671,000</td>
</tr>
<tr>
<td>5 Micronutrient</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Standard @ $1.10/MT Flour</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

domestic and imported flour. For example, after national fortification was implemented in Indonesia, nearly 20% of the market share was lost to a flood of less expensive imports. Building effective food-control systems, including ports and customs inspectors, is critical to protect millers who comply with regulations. Food-control systems are thus a key component of the Indonesia flour fortification proposal.

A key barrier to the widespread support of flour fortification in the ASEAN countries is the common belief that, since only about half of the populations of Thailand, Viet Nam, and Indonesia regularly consume flour products, and these consumers are overwhelmingly urban and middle to upper income, fortification would have no public health impact. To test this perception, the Country Teams used a rough consumer segmentation to project estimated reductions in the prevalence of IDA. The segmentation clearly reflects that most flour consumers are not low income or high risk. Though based on limited data, the flour consumer profiles for the three countries were very similar. The segmentations and related assumptions are as follows.33

Low-Risk, More Affluent, and Urban Flour Consumers
- represent 11.5–15% of the population
- consume half the flour of low-risk consumers
- anemia prevalence assumed to be twice that of low-risk consumers.

Nonconsumers
- represent 55%–60% of the population
- consume no flour on a regular basis and therefore receive no benefit
- anemia prevalence assumed to be the same as the high-risk group.

A scenario projecting the impact of flour fortification on the prevalence of IDA and FAD was run for four population groups: pregnant women, adult women, men, and children. For Viet Nam, the scenario was based on an MOH National Institute of Nutrition survey showing consumption levels of 125 grams per day of flour from bread, noodles, and other products among 15% of low-income women in rural areas. The projected impact on IDA for Vietnamese women is shown in Table 10. With flour fortification, reduction in prevalence is around 7% for women who consume flour products. However, national prevalence decreases only about 2%, since more than half the high-risk population is assumed to consume no flour products and therefore receives no benefit. For the three ASEAN countries, the consumer segmentation scenario shows IDA reduction of 2–8% among consumers and 1–3% for the national population. The impact of added folic acid was also estimated, although no correction for socioeconomic class was made. In Indonesia, it was projected that the addition of folic acid delivered via flour fortification would save 100,000 lives over 10 years, due to a reduction in birth defects and coronary heart disease.

Under current conditions and market patterns, flour fortification is clearly no panacea for micronutrient deficiencies.
malnutrition in Asia. However, in these three ASEAN countries, more than 200 million consumers would benefit from the addition of iron to flour. Table 11 shows the projected benefits and costs of flour fortification in the three ASEAN countries over a 10-year period. The benefit-cost ratio indicates that for every dollar invested, flour fortification with iron and folic acid returns $4–9 in decreased mortality and health costs, improved current productivity, and increased future productivity from improved cognitive development attributable to lower anemia rates in childhood. As flour consumption grows, particularly among low-income and rural consumers, these returns will rise dramatically.

Flour Fortification in the PRC and SAARC Countries such as Pakistan

In Pakistan and the western PRC, wheat flour products such as bread and noodles are staple foods that are traditionally grown, milled, and consumed throughout rural and low-income populations. As seen in Table 12, given the high per capita consumption of flour, the added intake of iron through flour fortification can be considerable.

Nonetheless, barriers to flour fortification exist in Pakistan and the PRC. The effectiveness of added vitamins and minerals, particularly iron, in the less-refined brown flours common in both Pakistan and the PRC is uncertain. Large-scale trials are ongoing in both countries to determine nutrition impact, consumer acceptability, and optimal fortification compounds. In the PRC, the trials utilize a domestically produced fortificant, NaFeEDTA (sodium iron ethylenediaminetetraacetic acid), a highly absorbable iron compound that overcomes the problem of low iron absorption in less-refined brown flours.

Both Pakistan and the PRC also face issues relating to industrial policy. In both countries, traditional village mills supply flour to more than half of flour consumers. These mills are most common in rural areas. While trials are showing the technical feasibility of fortification in small mills, commercial viability at this small scale has not been demonstrated. Moreover, there are complex issues of communication, quality assurance, and food control, given the literally tens of thousands of small producers. As Table 13

---

**TABLE 11: Ten-Year Benefits and Costs of Fortifying Flour with Iron and Folic Acid**

<table>
<thead>
<tr>
<th>Benefits ($'000)</th>
<th>Costs* ($'000)</th>
<th>Benefit-Cost Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indonesia</td>
<td>104,134</td>
<td>20,586</td>
</tr>
<tr>
<td>Thailand</td>
<td>13,400</td>
<td>2,759</td>
</tr>
<tr>
<td>Viet Nam</td>
<td>37,105</td>
<td>3,815</td>
</tr>
</tbody>
</table>

*Note that the total costs in the Indonesia and Thailand CIPs are higher because they include a premix made up of five micronutrients. The cost-benefit analysis here measures only the benefits of iron and folic acid, and therefore only these costs are used here. Costs may include applicable taxes and duties.

**TABLE 12: Projected Effects of Flour Fortification in Pakistan and the PRC**

<table>
<thead>
<tr>
<th>Consumption of Flour by Low-Income Individuals (grams/day)</th>
<th>Added Iron @ 60 ppm (milligrams/day)</th>
<th>% Daily Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pakistan</td>
<td>302</td>
<td>18</td>
</tr>
<tr>
<td>PRC</td>
<td>191</td>
<td>11</td>
</tr>
</tbody>
</table>

**TABLE 10: Consumer Segmentation Analysis for Adult Women: Impact of Fortified Flour on IDA in Viet Nam**

<table>
<thead>
<tr>
<th>IDA Prevalence Before Fortification</th>
<th>Iron Delivered via Fortification</th>
<th>Est. Prevalence Reduction after Fortification</th>
</tr>
</thead>
<tbody>
<tr>
<td>High-Risk Consumers (15% of the population)</td>
<td>47.3%</td>
<td>7.5 mg/day</td>
</tr>
<tr>
<td>Low-Risk Consumers (30% of the population)</td>
<td>23.6%</td>
<td>8.4 mg/day</td>
</tr>
<tr>
<td>Nonconsumers (55% of the population)</td>
<td>47.3%</td>
<td>0</td>
</tr>
<tr>
<td>National Summary</td>
<td>40.2%</td>
<td>2.4%</td>
</tr>
</tbody>
</table>

Note that the total costs in the Indonesia and Thailand CIPs are higher because they include a premix made up of five micronutrients. The cost-benefit analysis here measures only the benefits of iron and folic acid, and therefore only these costs are used here. Costs may include applicable taxes and duties.

---

TABLE 13: Mill Segmentation in the Western PRC

<table>
<thead>
<tr>
<th>Annual Capacity (MT)</th>
<th>Number of Mills</th>
<th>% Capacity of the Western PRC</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt;100,000</td>
<td>75</td>
<td>2.1%</td>
</tr>
<tr>
<td>50,000–100,000</td>
<td>480</td>
<td>3.4%</td>
</tr>
<tr>
<td>25,000–50,000</td>
<td>1,500</td>
<td>5.4%</td>
</tr>
<tr>
<td>12,500–25,000</td>
<td>7,500</td>
<td>14.3%</td>
</tr>
<tr>
<td>&lt;12,500</td>
<td>98,000</td>
<td>74.8%</td>
</tr>
</tbody>
</table>

reveals, there are nearly 100,000 small milling enterprises in the western PRC alone.

The PRC and Pakistan CIPs address these barriers in very different ways. The Pakistan plan addresses the challenges of quality assurance and food control with a conservative strategy that proposes to achieve fortification at 690 large-scale roller mills covering approximately 45% of the population. A program of research and development to enable smaller chakki mills (small-scale stone mills) to fortify is proposed for the future. To enable sustained fortification at the large roller mill level, the CIP proposes significant investment in improving governance and creating consumer awareness to create an enabling business environment. The CIP also proposes temporary micronutrient mix subsidies. Even though this large-mill strategy limits access to fortified flour to a mostly urban population, the CIP analysis suggests national IDA prevalence reductions in the range of 9–10%. The resulting 10-year productivity improvements are estimated at more than $262 million, as shown in Table 14. An additional $75 million in benefits are projected from the provision of folic acid in flour fortification.

TABLE 14: Ten-Year Economic Impact of Projected Reductions in IDA Prevalence via Flour Fortification in Pakistan

<table>
<thead>
<tr>
<th>Gains Made</th>
<th>Economic Impact ($ million)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Productivity Gain from</td>
<td></td>
</tr>
<tr>
<td>Improvements in Childhood Cognition</td>
<td>169.30</td>
</tr>
<tr>
<td>Blue Collar Productivity Gains</td>
<td>27.92</td>
</tr>
<tr>
<td>Manual Labor Productivity Gains</td>
<td>65.12</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>262.34</strong></td>
</tr>
</tbody>
</table>

The CIP from the People’s Republic of China positions fortification as a component of the overall transition of the PRC’s western provinces to a more prosperous industrialized region. The western region is also the focus of a poverty reduction agreement with ADB. The CIP envisions developing the large mill sector in the western region, as well as expanding distribution of flour from large mills in the northeast PRC. As quality assurance regulations are enforced and fortification becomes mandatory in the later years of the 10-year plan, many of the small mills will be consolidated into larger operations. The CIP proposes intensive marketing campaigns to create consumer awareness of both the higher quality and improved nutrition available from industrially produced fortified flours. The PRC used a similar strategy for iodized salt—upgrading the industrial capacity and product quality to establish and sustain more than 90% coverage of iodized salt. There is every reason to believe that the proposed strategy for flour fortification can be equally successful.

The product introduction strategy is a key element in the PRC CIP. The first step in the program is to provide fortified flour through a public distribution program for populations displaced by the modernizing landscape of the western PRC. This program is both a well-targeted public health intervention and a strategy to transition the market to higher-quality flour products. As consumers are introduced to this product and as industrially produced flour becomes more easily accessible, fortification will become a sustained part of the developing food markets in northwestern PRC.

In both Pakistan and the PRC, engineering a transition from traditional flour products and a small-mill environment is complex. The needed start-up investments in industrial upgrades, food control, nutrition surveillance, and extensive social marketing are relatively high. Table 15 shows that, while projected prevalence reductions are also relatively high, the CIPs estimate a 10-year benefit-cost ratio in the range of 2.1–3.1. These ratios may be deceptively low, however. In the case of Pakistan, the benefits are limited to less than half the population and by the low bioavailability of iron in unrefined atta (brown) flour. In the PRC, the relatively low benefit-cost ratio is in large part attributable to the high cost of domestically procured premix. As these assumptions change, the benefit-cost ratios for

---

36 Domestically procured premix is estimated at about twice the cost of other CIPs based on the standard rates of international suppliers.
Pakistan and the PRC may well surpass those of the ASEAN countries.

Table 16 summarizes the status of the flour fortification programs in each of the five countries of interest.

<table>
<thead>
<tr>
<th>TABLE 16: Maturity of CIP Flour Fortification Programs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Program Stage</td>
</tr>
<tr>
<td>Indonesia</td>
</tr>
<tr>
<td>Pakistan</td>
</tr>
<tr>
<td>PRC</td>
</tr>
<tr>
<td>Thailand</td>
</tr>
<tr>
<td>Viet Nam</td>
</tr>
</tbody>
</table>

New Products to Address Micronutrient Malnutrition in Asia: Fish Sauce and Soy Sauce Fortification

In countries where rice is the dominant staple food, micronutrient malnutrition is often the most severe. For a number of reasons, it is not possible to fortify rice with critical vitamins and minerals. The development of micronutrient-rich strains of rice via biotechnology and plant breeding is ongoing, but for the time being these approaches remain developmental and not yet at a commercial scale.

The fortification of condiments, however, offers a promising strategy to benefit rice-eating populations. The 1980s saw a public-private collaboration to develop monosodium glutamate (MSG) fortified with vitamin A in Indonesia. Technical barriers and strained communications between public and private organizations brought that project to a halt, but at some future date it may be revived. In South Asia and Africa, tests are ongoing to develop a salt fortified with both iodine and iron. Today, after several years of product development, testing, and close cooperation among governments, manufacturers, and international agencies, iron-fortified fish sauce and soy sauce are ready for market.

In the PRC, Thailand, and Viet Nam, more than 80% of the population, including people in all socioeconomic groups, regularly consume fish or soy sauce at an average of 10-15 milliliters per person per day. Low-income consumers typically consume 60-70% of the national average, which is still sufficient to deliver significant levels of iron. In these three countries, significant segments of the market are in the hands of large producers who are organized, sophisticated, and, over the past several years, in communication with public health authorities regarding fortification. Table 17 shows the number of producers of fish and soy sauce in the three countries, and the number and percentage of those that are large producers.

Product Development

Until recently, fish and soy sauce had not been considered potential fortification vehicles due to questions of product quality and consumer acceptance. Traditional iron salts precipitated, with resulting color and taste changes during storage and the cooking of traditional dishes. However, two solutions have been developed. Food technologists working at Mahidol University in Thailand developed a formulation that includes ferrous sulfate, along with

| TABLE 15: Benefits and Costs of Flour Fortification in Pakistan and the PRC |
|-----------------------------|-----------------------------|-----------------------------|
| Benefit ($’000) | Cost ($’000) | Benefit-Cost Ratio |
| Pakistan  | 337,862 | 165,416 | 2.0 |
| PRC        | 543,346 | 184,125 | 3.0 |

For a number of reasons, it is not possible to fortify rice with critical vitamins and minerals. The development of micronutrient-rich strains of rice via biotechnology and plant breeding is ongoing, but for the time being these approaches remain developmental and not yet at a commercial scale.

The fortification of condiments, however, offers a promising strategy to benefit rice-eating populations. The 1980s saw a public-private collaboration to develop monosodium glutamate (MSG) fortified with vitamin A in Indonesia. Technical barriers and strained communications between public and private organizations brought that project to a halt, but at some future date it may be revived. In South Asia and Africa, tests are ongoing to develop a salt fortified with both iodine and iron. Today, after several years of product development, testing, and close cooperation among governments, manufacturers, and international agencies, iron-fortified fish sauce and soy sauce are ready for market.

In the PRC, Thailand, and Viet Nam, more than 80% of the population, including people in all socioeconomic groups, regularly consume fish or soy sauce at an average of 10-15 milliliters per person per day. Low-income consumers typically consume 60-70% of the national average, which is still sufficient to deliver significant levels of iron. In these three countries, significant segments of the market are in the hands of large producers who are organized, sophisticated, and, over the past several years, in communication with public health authorities regarding fortification. Table 17 shows the number of producers of fish and soy sauce in the three countries, and the number and percentage of those that are large producers.

Product Development

Until recently, fish and soy sauce had not been considered potential fortification vehicles due to questions of product quality and consumer acceptance. Traditional iron salts precipitated, with resulting color and taste changes during storage and the cooking of traditional dishes. However, two solutions have been developed. Food technologists working at Mahidol University in Thailand developed a formulation that includes ferrous sulfate, along with

<table>
<thead>
<tr>
<th>TABLE 16: Maturity of CIP Flour Fortification Programs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Program Stage</td>
</tr>
<tr>
<td>Indonesia</td>
</tr>
<tr>
<td>Pakistan</td>
</tr>
<tr>
<td>PRC</td>
</tr>
<tr>
<td>Thailand</td>
</tr>
<tr>
<td>Viet Nam</td>
</tr>
</tbody>
</table>

New Products to Address Micronutrient Malnutrition in Asia: Fish Sauce and Soy Sauce Fortification

In countries where rice is the dominant staple food, micronutrient malnutrition is often the most severe. For a number of reasons, it is not possible to fortify rice with critical vitamins and minerals. The development of micronutrient-rich strains of rice via biotechnology and plant breeding is ongoing, but for the time being these approaches remain developmental and not yet at a commercial scale.

The fortification of condiments, however, offers a promising strategy to benefit rice-eating populations. The 1980s saw a public-private collaboration to develop monosodium glutamate (MSG) fortified with vitamin A in Indonesia. Technical barriers and strained communications between public and private organizations brought that project to a halt, but at some future date it may be revived. In South Asia and Africa, tests are ongoing to develop a salt fortified with both iodine and iron. Today, after several years of product development, testing, and close cooperation among governments, manufacturers, and international agencies, iron-fortified fish sauce and soy sauce are ready for market.

In the PRC, Thailand, and Viet Nam, more than 80% of the population, including people in all socioeconomic groups, regularly consume fish or soy sauce at an average of 10-15 milliliters per person per day. Low-income consumers typically consume 60-70% of the national average, which is still sufficient to deliver significant levels of iron. In these three countries, significant segments of the market are in the hands of large producers who are organized, sophisticated, and, over the past several years, in communication with public health authorities regarding fortification. Table 17 shows the number of producers of fish and soy sauce in the three countries, and the number and percentage of those that are large producers.

Product Development

Until recently, fish and soy sauce had not been considered potential fortification vehicles due to questions of product quality and consumer acceptance. Traditional iron salts precipitated, with resulting color and taste changes during storage and the cooking of traditional dishes. However, two solutions have been developed. Food technologists working at Mahidol University in Thailand developed a formulation that includes ferrous sulfate, along with

| TABLE 15: Benefits and Costs of Flour Fortification in Pakistan and the PRC |
|-----------------------------|-----------------------------|-----------------------------|
| Benefit ($’000) | Cost ($’000) | Benefit-Cost Ratio |
| Pakistan  | 337,862 | 165,416 | 2.0 |
| PRC        | 543,346 | 184,125 | 3.0 |
0.3% citric acid as a chelating agent, that does not cause changes in sensory features. This formulation has been tested at Mahidol University, private Thai labs, and the Swiss Federal Institute of Technology to determine the bioavailability of the iron and product acceptability. The concept has been introduced to Thai fish sauce producers.

Viet Nam’s National Institute of Nutrition (NIN) and the Chinese Academy of Preventive Medicine (CAPM)—working in close collaboration with the International Life Sciences Institute—have taken a different route, using the fortificant sodium iron ethylenediaminetetraacetic acid, or NaFeEDTA. This novel iron compound, approved by the Joint FAO/World Health Organization (WHO) Expert Committee on Food Additives, has interested nutritionists for a number of years due to its enhancing effect on iron absorption. In high-cereal diets, such as the rice-based meals of Viet Nam and the PRC, NaFeEDTA has been found to be 2-5 times more bioavailable than traditional iron compounds. And it has another key advantage. NaFeEDTA does not precipitate out or cause any negative product change. The CAPM and NIN undertook a series of efficacy and effectiveness trials—the latter involving more than 20,000 individuals. The trials revealed a decreased IDA prevalence of 50% or more. Therefore, NaFeEDTA-fortified fish and soy sauce provide among the best-documented examples of positive impact from an iron fortification intervention.

Plan for Commercial Implementation

The stage is thus set for the commercial launch of fortified fish and soy sauce. In both the PRC and Viet Nam, food standards have been amended to allow the addition of NaFeEDTA to fish sauce and soy sauce. A factory in the PRC is currently producing NaFeEDTA and has the ability to expand (within its current facility) to meet the needs of the PRC’s domestic fortification programs—and possibly others. The PRC, Thailand, and Viet Nam CIPs plan for an expansion of fish and soy sauce fortification to 50-90% of production in 10 years. (See Table 18.) Industrial upgrades are expected to be minimal. In some cases, factories will need to install mixing tanks. All will need to invest in appropriate quality assurance systems.

In Thailand, close communication with the Thai National Producers Association is expected to ensure the participation of its 20 member companies within 5 years. In Viet Nam, where the government is part-regulator and part-owner of the fish sauce industry (via the Ministry of Fisheries), a 5-year plan envisions

<table>
<thead>
<tr>
<th>TABLE 17: Industrial Environment for Fish and Soy Sauce Fortification</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>PRC</td>
</tr>
<tr>
<td>Thailand</td>
</tr>
<tr>
<td>Viet Nam</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>TABLE 18: Projected Reach of Fish and Soy Sauce Fortification Programs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population</td>
</tr>
<tr>
<td>PRC</td>
</tr>
<tr>
<td>Thailand</td>
</tr>
<tr>
<td>Viet Nam</td>
</tr>
<tr>
<td>Total Coverage</td>
</tr>
</tbody>
</table>
the expansion of fortification throughout the large-scale sector, and subsequently a “consolidation phase” in which the operations of many small-scale producers will be incorporated into the larger companies. In the PRC, close collaboration between the Chinese Academy for Preventive Medicine and the China National Soy Sauce Producers Association is drawing widespread support among producers. Participation in the first year of the program is by application only. The PRC CIP proposes the expansion of production over 10 years to 200 large refineries, sufficient to cover a population of 500 million.

In both Viet Nam and the PRC, fortification is framed as part of an overall plan to establish more effective and transparent systems for food quality and safety. This is reflected in substantial proposed investments in food control and surveillance, as shown in Table 19. In Thailand, the desired investment in food control systems is lower because these activities are limited to about 20 large companies, and because food analysis is “privatized,” with routine tests at accredited private laboratories required by the Thai Ministry of Public Health’s Nutrition Seal program.

In Thailand, Nutrition Seal promotions and a national product introduction campaign will target acceptance by consumers. The marketing budget is relatively small, with no planned expansion beyond the 80% market share currently held by the large producers and association members. However, due to a number of market factors, including fortification, gains in market share to 90% over 10 years seem reasonable to project.

Fish sauce fortification in Viet Nam will be well targeted, because only mid- and lower-quality product will be fortified. For the large majority of consumers, the transition to fortification will be invisible; they will purchase the same product from the same supplier at a competitive price. Over 10 years, the CIP projects a 25% increase in market share for large-scale producers from 70% to about 90% of consumption. This gain will come specifically in rural areas currently supplied by small producers. Social marketing, with an emphasis on the participation of local governments and NGOs, is expected to raise awareness and demand in rural areas to support this modest transition and consolidation.

### Table 19: Ten-Year Food Control, Monitoring, and Marketing Costs for Fish and Soy Sauce Fortification

<table>
<thead>
<tr>
<th></th>
<th>Proposed Food Control and Monitoring Budget</th>
<th>Proposed Ten-Year Marketing Budget</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Amount ($)</td>
<td>% of Total Program</td>
</tr>
<tr>
<td>PRC</td>
<td>4,900,000</td>
<td>2.04</td>
</tr>
<tr>
<td>Thailand</td>
<td>221,840</td>
<td>.5</td>
</tr>
<tr>
<td>Viet Nam</td>
<td>2,163,000</td>
<td>9.95</td>
</tr>
</tbody>
</table>

#### Marketing and Targeting

Each CIP proposes collaborative, public-private activities to gain producer participation and build consumer awareness and demand. In all cases, consumer marketing is focused on education and behavior change among the highest-risk consumers, primarily in rural areas. The market share gained by large industries as a result of fortification will predominantly be due to increased consumption among the rural poor.

The PRC is embarking on a marketing challenge, proposing to shift a significant number of consumers from traditional, village-made products to bottled, industrial commodities from quality assured factories offering Good Manufacturing Practices (GMP) and Hazard Analysis and Critical Control Point (HACCP) systems. This transition to higher-quality and more nutritious products involves a price increase of some 50%—primarily due to an overall higher-quality product and glass bottle. At average consumption, this would amount to
an additional cost of about $0.32 per year. There are numerous examples of rural Chinese consumers moving to higher-quality and more expensive products as these become available. To facilitate this market transition, the PRC CIP proposes new distribution and marketing systems that specifically target high-risk areas. The plan’s target is 50% of market share in these areas after 10 years.

**Costs and Benefits**

According to the CIP analyses, the fortification of fish and soy sauce offers the most cost-effective opportunity to improve nutrition and health in Asia. Discounting effectiveness trials as much as 50%, the CIPs from the PRC and Viet Nam project 25–30% reductions in the national prevalence of IDA. The benefit-cost analyses for Viet Nam and the PRC estimate a $9–12 return for every dollar invested in these projects. Thailand, with a lower baseline prevalence of IDA, projects a more modest reduction and a benefit-cost ratio of almost 7:1. (See Table 20.)

**TABLE 20: The Benefits and Costs of Soy and Fish Sauce Fortification**

<table>
<thead>
<tr>
<th></th>
<th>Benefit ($'000)</th>
<th>Cost ($'000)</th>
<th>Benefit-Cost Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>PRC</td>
<td>2,250,238</td>
<td>240,238</td>
<td>9.4</td>
</tr>
<tr>
<td>Thailand</td>
<td>160,725</td>
<td>24,463</td>
<td>6.6</td>
</tr>
<tr>
<td>Viet Nam</td>
<td>257,825</td>
<td>21,740</td>
<td>11.9</td>
</tr>
</tbody>
</table>

**Investing in Complementary Foods: New Approaches to Reaching the Most Vulnerable Population in Asia**

“Complementary foods” are semisolid foods fed to infants and very young children as complement to breast-feeding or commercial or homemade formula, as a means of better meeting the nutritional requirements of the child. Complementary foods offer an opportunity to optimize child growth and cognitive development in Asia, which has the highest prevalence of underweight and stunted children in the world. By targeting the most vulnerable population in Asia at a critical time in life, the returns in lives saved will be immeasurable and the savings in reduced illness and future productivity will be enormous.

Commercial complementary foods have already been introduced to the rural poor in Asia. In the PRC’s western provinces and in rural Viet Nam, 13-17% of children under 2 years old have consumed commercial complementary foods. (See Table 21.)

Public distribution of complementary foods in Indonesia indicates that, when available, commercial complementary foods are well accepted; surveys of the UNICEF-sponsored Vitadeli program indicate an 86% positive response. Both multinational companies and domestic firms produce fortified complementary foods on a large scale in Asia, and supply could easily be increased. Nonetheless, a number of barriers remain to the penetration of low-income areas.

**Focus on Reducing Costs and Increasing Access**

Despite evidence of consumer acceptance and some demand, the relatively high cost of commercial complementary foods prevents timely and consistent use among the majority of low-income families. In addition, barriers to access exist in poor urban neighborhoods and rural areas. An analysis of the Indonesian market shows that, while 100% of upper-income segments have access to commercial complementary foods, the products are simply not easily available for the overwhelming majority. (See Table 22.)

An analysis of the industry’s cost structure for complementary foods, shown in Figure 3, reveals that 50% of the resources are applied to raw materials, production costs, and company overhead. The remaining 50% is spent on packaging, distribution, and marketing. The CIPs for Indonesia, the PRC, Thailand, and Viet Nam address both sides of this cost equation. The objective of the CIPs’ proposed public-private investment projects is to increase access and affordability to low-income consumers by reducing production costs and improving the efficiency of distribution and marketing. Both sides of this equation are discussed in the next two sections.

37 As elsewhere in this document, these figures cover only the western provinces of the PRC, not the whole country.
Production Strategies and Product Formulations

Product formulation and development is complete for two of the projects proposed in the CIPs. Today in Thailand, broken rice kernels are ground and packaged as an inexpensive convenience food that is widely purchased in rural and low-income areas. The Thailand CIP proposes that this dried ground rice be fortified with calcium, iron, vitamin B₁, and folic acid at 33% of the Thai RDA per serving, using technology that is available in-plant. (See Table 23.)

The fortificants cost $7 per metric ton of dried ground rice. Fortification has been tested at the industrial level for stability and acceptance. One producer is committed to introducing the product. Additional ground rice producers will be approached at a later time, after the initial product has been introduced and the market development activities proposed in the CIP are underway.

In Viet Nam, a fortified complementary food called Favina has been test-marketed in three rural areas for 24 months. An initial biochemical evaluation indicates that this product has reduced the prevalence of IDA by more than 50%. (Other results are not yet available.) While the formulation, with 18 vitamins and minerals, is not novel, the production approach is innovative. Since Viet Nam has no centralized, large-scale, domestic manufacturing capacity, the product is manufactured by small production units, each with a 50 kg per hour capacity. The Viet Nam CIP proposes a 10-year expansion from the current three production units to 50, which would be sufficient to produce 8,500 MT annually and cover 15% of Viet Nam’s lower-income 6- to 24-month olds. The capital investment for each unit—including a hammer mill, extruder, and other processing and packaging equipment—is $6,000. Building and renovation needs are estimated at an additional

---

**TABLE 21: Percentage of Infants in the PRC’s Five Western Provinces Introduced to Commercial Complementary Food**

<table>
<thead>
<tr>
<th>Age (months)</th>
<th>Guizhou (%)</th>
<th>Gansu (%)</th>
<th>Ningxia (%)</th>
<th>Qinghai (%)</th>
<th>Xinjiang (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>6–9</td>
<td>20.6</td>
<td>9.7</td>
<td>6.2</td>
<td>7.1</td>
<td>15.7</td>
</tr>
<tr>
<td>9–12</td>
<td>24.6</td>
<td>14.1</td>
<td>10.1</td>
<td>8.8</td>
<td>18.9</td>
</tr>
<tr>
<td>12–18</td>
<td>28.1</td>
<td>18.9</td>
<td>12.6</td>
<td>11.0</td>
<td>23.3</td>
</tr>
<tr>
<td>18–24</td>
<td>30.0</td>
<td>21.2</td>
<td>16.9</td>
<td>14.2</td>
<td>26.1</td>
</tr>
</tbody>
</table>

**TABLE 22: Access to Commercial Complementary Foods by Socioeconomic Segment in Indonesia**

<table>
<thead>
<tr>
<th>Socioeconomic Segment</th>
<th>Baby Population</th>
<th>% with Access to Commercial Comp. Foods</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>287,200</td>
<td>100</td>
</tr>
<tr>
<td>B</td>
<td>513,900</td>
<td>100</td>
</tr>
<tr>
<td>C</td>
<td>2,335,000</td>
<td>38</td>
</tr>
<tr>
<td>D</td>
<td>2,313,300</td>
<td>23</td>
</tr>
</tbody>
</table>

**TABLE 23: Fortification Profile of Fortified Ground Rice, as Proposed in the Thailand CIP**

<table>
<thead>
<tr>
<th>Micronutrient</th>
<th>Level per 100 kcal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calcium</td>
<td>40.00 mg</td>
</tr>
<tr>
<td>Iron</td>
<td>5.30 mg</td>
</tr>
<tr>
<td>Vitamin B₁</td>
<td>.08 mg</td>
</tr>
<tr>
<td>Folic Acid</td>
<td>11.00 µg</td>
</tr>
</tbody>
</table>

---

38 These figures are drawn from the PRC CIP, summarized later in this chapter.
39 Table supplied by Gizindo Foods, Indonesia.
40 Segment A includes the wealthiest members of the population. Segment D is made up of the poorest who take part in the cash economy. Those in Segment E, not included here, do not take part in the cash economy at all.
41 Personal Communication, Dr. Jacques Berger, Principal Investigator.
$5,000–$6,000 per unit. The National Institute of Nutrition—along with a French NGO, Group D’Exchange et de Recherche Technologique (GRET)—supply training, fortificant, and other critical inputs. The basic ingredients (rice, soy, and sugar) are purchased from surrounding agricultural markets. The Viet Nam Women’s Union (VWU), with a network throughout the rural countryside, is committed to identifying local partners and entrepreneurs. It should be noted that the pilot facilities are up and running, with sufficient sales to make adequate if not handsome profits.

The Indonesia CIP proposes to develop a lower-cost product in collaboration with Gizindo Foods, a large domestic producer that has been involved with the Indonesian Ministry of Health on several emergency distribution programs for children. The cost structure reflects excessive costs for packaging (Figure 2). Product trials will focus on key cost-savings measures, including bulk distribution at the retail level rather than small, sealed packages. Formulations that succeed in reducing packaging needs—and therefore 20% of the cost—offer the promise of lower-cost foods that can reach 6- to 24-month olds in desperate need.

![Figure 2: Cost Structure of Commercial Complementary Foods in Indonesia](image)

The PRC CIP proposes to pursue two parallel product strategies for complementary foods. First, talks are ongoing with large multinational suppliers to distribute their current products via the PRC’s Ministry of Health and NGO channels in the country’s poor, rural western areas. The CIP asserts that higher production volumes offered by these bulk sales to public entities will be attractive to producers, and will lower overall unit costs. Moreover, the CIP asserts that public distribution will lower retail costs by as much as 50%. A second approach involves micronutrient-fortified “sprinkles,” a new product concept featuring a powdered micronutrient supplement that is added to infants’ normal complementary food in the home. In both cases, the CIP asserts that reductions in private profit and overhead can significantly reduce costs.

**Approaches to Marketing and Distribution**

Industry’s estimate that marketing and distribution comprise 30% of the total cost is based on experience in a relatively affluent market for complementary foods. Reaching lower-income and less-informed consumers in less-accessible areas will likely mean spending more than the current 30% on marketing and distribution. Therefore, the CIPs include a variety of public-private partnerships that aim to simultaneously decrease costs and increase the scope of distribution to rural areas.

The CIP from Indonesia proposes to capitalize on a partnership with DULOG, Indonesia’s national logistics agency. This large, public distribution agency is currently supplying subsidized rice to the poorest 10% of the population. DULOG has an extensive network of warehouses and distribution points in all provinces, reaching into the most remote districts. DULOG will partner with producers and the Indonesian Ministry of Health on a 10-year distribution plan that aims to reach 25% of at-risk 6- to 12-month olds in all of the nation’s 256 rural districts. In addition to commercial channels, the proposed system features distribution to remote rural retail outlets via local governments and health care agencies.

---

42 Neither of these strategies have been as extensively developed or tested as those mentioned previously.

43 “Sprinkles” technology is often referred to as “in-home fortification.”
posts, as well as direct marketing via networks of midwives and health workers. The estimated DULOG distribution charge is 10% of the product's value. Reaching 200,000 rural stores and midwives, the marketing and distribution plan involves investments in training and motivation for district level DULOG and MOH personnel. (See Table 24.) Incentives include a small revolving fund to cover the initial month's inventory, marketing materials, and point-of-purchase aids. After product development is complete, the CIP proposes to achieve target distribution within one year.

In Viet Nam, 50 small-scale, rural-based production facilities will be complemented by a decentralized distribution and sales network capable of reaching into remote villages. As illustrated in Figure 4, the distribution lines will reflect the organization of the VWU, a major project partner. Producers will distribute not only to retail outlets, but directly to commune-level VWU leaders. As intermediate distribution points, the commune leaders will distribute the product and monitor numerous, village-level VWU collaborators. The collaborators will be involved in actual home visits in remote rural areas. This proposed grassroots marketing and distribution structure is already in place within the VWU and has been successfully piloted in three areas.

While community service remains the bottom-line motivation for VWU volunteers, both commune leaders and collaborators will receive a percentage of sales. As shown in Figure 3, sales via the VWU distribution channel will be augmented by distribution to local stores and sales to other NGOs. The program is based on the proposition that providing a nutritious product goes hand-in-hand with education for child feeding and care. Therefore, a significant part of the CIP budget is devoted to training VWU collaborators and producing materials to be used in the face-to-face village context. With this home educational component, nutrition benefits for children should accrue even if a sale is not made.

The Thailand CIP does not propose to build an additional distribution system, but rather it grafted a new fortified product line onto the existing distribution system for packaged ground rice. This distribution system currently reaches deep into rural and low-income areas. While the project will look to

<table>
<thead>
<tr>
<th>TABLE 24: Scope and Elements of Rural Distribution Plan for Complementary Foods in Indonesia</th>
</tr>
</thead>
<tbody>
<tr>
<td>6- to 12-Month Olds Reached Annually (given 25% coverage)</td>
</tr>
<tr>
<td>Total National Consumers and Retail Outlets</td>
</tr>
<tr>
<td>Estimated Consumers and Outlets per District (256 nationwide)</td>
</tr>
</tbody>
</table>

In Viet Nam, 50 small-scale, rural-based production facilities will be complemented by a decentralized distribution and sales network capable of reaching into remote villages. As illustrated in Figure 4, the distribution lines will reflect the organization of the VWU, a major project partner. Producers will distribute not only to retail outlets, but directly to commune-level VWU leaders. As intermediate distribution points, the commune leaders will distribute the product and monitor numerous, village-level VWU collaborators. The collaborators will be involved in actual home visits in remote rural areas. This proposed grassroots marketing and distribution structure is already in place within the VWU and has been successfully piloted in three areas.

While community service remains the bottom-line motivation for VWU volunteers, both commune leaders and collaborators will receive a percentage of sales. As shown in Figure 3, sales via the VWU distribution channel will be augmented by distribution to local stores and sales to other NGOs. The program is based on the proposition that providing a nutritious product goes hand-in-hand with education for child feeding and care. Therefore, a significant part of the CIP budget is devoted to training VWU collaborators and producing materials to be used in the face-to-face village context. With this home educational component, nutrition benefits for children should accrue even if a sale is not made.

The Thailand CIP does not propose to build an additional distribution system, but rather it grafted a new fortified product line onto the existing distribution system for packaged ground rice. This distribution system currently reaches deep into rural and low-income areas. While the project will look to

<table>
<thead>
<tr>
<th>FIGURE 3: Distribution System for Complementary Foods in Viet Nam</th>
</tr>
</thead>
<tbody>
<tr>
<td>National Institute of Nutrition, (GINET), Technical Assist, QA, and Supply</td>
</tr>
<tr>
<td>PRODUCTION UNIT</td>
</tr>
<tr>
<td>Rural Retail Outlets, NGO and Government Distribution Programs</td>
</tr>
<tr>
<td>Various Market or Catchement Areas</td>
</tr>
<tr>
<td>10-20 Mothers with Children Ages 6-24 Months per Village</td>
</tr>
<tr>
<td>One Collaborator per Village</td>
</tr>
<tr>
<td>Three Main Collaborators per Commune (Communal Women’s Union)</td>
</tr>
<tr>
<td>Two Main Trainers (District Women’s Union)</td>
</tr>
<tr>
<td>Provincial Steering Committee (Provincial Women’s Union)</td>
</tr>
<tr>
<td>Central Steering Committee (District Women’s Union)</td>
</tr>
</tbody>
</table>

The market for complementary foods is small. The four CIPs describe different target markets. (See
Table 25.) Some focus on 6- to 12-month olds, while others target 6- to 24-month olds—effectively tripling the size of the market. Expanding this market still further to 36-month olds is a possibility. In all cases, however, the CIPs plan to reach a significant proportion of rural and/or high poverty areas—between 15% and 100% of at-risk children, as shown in Table 25. Over 10 years, more than 18 million children will benefit.

### TABLE 25: Annual Coverage: Markets Outlined in the CIPs’ Complementary Foods Projects

<table>
<thead>
<tr>
<th>Market</th>
<th>% of Market to Definition</th>
<th># of Children Covered Each Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indonesia</td>
<td>6- to 12-month olds, mainly in rural areas</td>
<td>50</td>
</tr>
<tr>
<td>PRC</td>
<td>6- to 36-month olds in five high-poverty areas of the western PRC</td>
<td>100</td>
</tr>
<tr>
<td>Thailand</td>
<td>6- to 12-month olds, mainly in rural areas</td>
<td>50</td>
</tr>
<tr>
<td>Viet Nam</td>
<td>low-income 6- to 24-month olds</td>
<td>15</td>
</tr>
</tbody>
</table>

Costs

The four complementary foods proposals in the CIPs structure 10-year costs differently. (See Table 26.) For the PRC, the “product or fortificant” figure includes only the incremental cost of the fortificant. The figure for Thailand includes the fortificant, packaging, and analytical costs. For Indonesia, it includes the entire cost of the food product. And for Viet Nam, it includes all labor, packaging, overhead, 7% tax, and the fortificant, but not the raw materials, such as soy, sugar, or rice. While all of the CIPs show a significant investment in marketing and distribution, different overall cost structures make comparisons difficult. In most cases, a benefit-cost analysis is not attempted, because the evidence is not available to quantify the impact of improved micronutrient status within this narrow age range (6–12 months) of improved nutrition, if fortification is not continued in later months. The Thai Country Team, which assumed that cognitive development is protected by fortification in this critical 6-month window, ran a benefit-cost analysis for improvement in iron status only, with the results suggesting a return of nearly $4 for each dollar invested. This positive benefit-cost ratio was achieved even though it included the cost of a multimicronutrient mix but only measured the benefits of improved iron status.

Table 27 shows the current status of the complementary foods programs outlined in the CIP.

### TABLE 26: Summary Costs of Proposed Complementary Foods Initiatives

<table>
<thead>
<tr>
<th></th>
<th>Indonesia ($)</th>
<th>PRC ($)</th>
<th>Thailand ($)</th>
<th>Viet Nam ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distribution and Marketing</td>
<td>20,574,000</td>
<td>8,800,000</td>
<td>285,313</td>
<td>6,975,434</td>
</tr>
<tr>
<td>Product or Fortificant Costs</td>
<td>45,990,000</td>
<td>3,419,600</td>
<td>3,215,476</td>
<td>34,626,639</td>
</tr>
<tr>
<td>Total</td>
<td>66,564,000</td>
<td>12,219,600</td>
<td>3,500,789</td>
<td>41,020,073</td>
</tr>
</tbody>
</table>

---

The distribution and marketing figures for the PRC, Thailand, and Viet Nam do not include all retail or sales mark-ups.
risk of mortality due to VAD. In Indonesia, Pakistan, and PRC the estimated consumption of oil among children of low-income backgrounds or households is sufficiently high to deliver 10–18% of the recommended daily intake (RDI) of vitamin A. (See Table 28.) The Country Teams’ surveys of industrial capacity indicate that the oil crushing and refining industry is relatively centralized and sophisticated and can adapt fortification technology with minimal costs. However, for a number of reasons, additional development work may be necessary prior to establishing national programs of oil fortification.

Given the low intake of oil among at-risk children as determined by consumption surveys, Thailand and Viet Nam are not proposing oil fortification at this time. However, national programs are proposed for Pakistan and Indonesia, as well as a targeted program for the PRC. These are projected to lower the prevalence of VAD by 13%–30% among children under 5 years of age. This could prevent about 100,000 deaths over the next 10 years. (See Table 29.)

- In Pakistan, where oil fortification has been mandated for half a century, the CIP analysis may bolster the case for a serious commitment to implementing that mandate and may open channels to gain support in both public and private sectors. With 116 producers supplying nearly 100% of the oil consumed, fortification is industrially feasible and offers wide population coverage.

### TABLE 28: Potential Delivery of Vitamin A to Low-Income Children via Fortified Oil

<table>
<thead>
<tr>
<th>Oil Consumption Among Low-Income, Rural Individuals</th>
<th>Daily Vitamin A that Could Be Delivered to Children via Oil Fortification</th>
<th>% Needs Met by Oil Fortification (given a child RDI of 400 µg/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adults (mg/day)</td>
<td>Children (mg/day)</td>
<td>(Retinol Equivalent µg/day)</td>
</tr>
<tr>
<td>Indonesia 46</td>
<td>21</td>
<td>5.25</td>
</tr>
<tr>
<td>Pakistan</td>
<td>24.3</td>
<td>8.1</td>
</tr>
<tr>
<td>PRC 47</td>
<td>7</td>
<td>4.5</td>
</tr>
<tr>
<td>Thailand</td>
<td>7</td>
<td>2.3</td>
</tr>
<tr>
<td>Vietnam 48</td>
<td>8.2</td>
<td>2.8</td>
</tr>
</tbody>
</table>

### Proposed Oil Fortification Programs

Given the low intake of oil among at-risk children as determined by consumption surveys, Thailand and Viet Nam are not proposing oil fortification at this time. However, national programs are proposed for Pakistan and Indonesia, as well as a targeted program for the PRC. These are projected to lower the prevalence of VAD by 13%–30% among children under 5 years of age. This could prevent about 100,000 deaths over the next 10 years. (See Table 29.)

- In Indonesia, where a large domestic oil industry provides for an affordable product with widespread consumption across all socioeconomic groups, the fortification of palm

---

45 These calculations are based on a fortification level of 15 µg/gram. Available vitamin A retained through storage and cooking is presumed to be 60% of that level.

46 Note that, for Indonesia, Pakistan, and Thailand, child consumption is estimated at 25% of adult consumption.

47 These figures were drawn from the PRC’s Third National Nutrition Survey, conducted in 1992.

48 A survey was conducted in low-income neighborhoods by NIN specifically for the CIP.
oil with vitamin A may provide a lever to simultaneously save lives and modernize the domestic industry. Indonesia’s 57 producers have a huge production capacity, and they supply both the domestic market and a large export market. Palm oil fortification is projected to reduce VAD prevalence by 13% in Indonesia, which could in turn avert more than 44,000 deaths and save more than $555 million in health care costs over 10 years. In the PRC’s southwestern province of Guizhou, a program targeting at-risk consumers with a new packaged oil product that conserves the stability of vitamin A is projected to avert 14,000 child deaths over 10 years.

Addressing Economic Barriers to Oil Fortification

Given the centralized nature of the industry, the projected expenses for industrial upgrades as well as government food control and regulation are relatively modest. However, retinol palmitate, the vitamin A fortificant compound used in oil fortification, is expensive relative to other micronutrients. Fortification at levels proposed for Indonesia (50 international units (IU) or 15 micrograms per gram), would add about $3 per MT to the cost of oil production. It is estimated that about 40% of the added retinol palmitate, at a cost of $1.20 per MT, is lost in storage, distribution, and cooking. Given these relatively high costs and fortificant losses, industrial and academic sectors require more data on vitamin A retention in the range of oil distribution, storage, and cooking conditions found in Asia. Consequently, additional product development, efficacy, and effectiveness trials are proposed in the Indonesia CIP. Table 30 outlines the estimated future oil fortification costs as proposed in the CIPs for Indonesia, Pakistan, and PRC.

The CIPs differ in their projected returns on investment for oil fortification. In the case of Viet Nam, oil fortification was not recommended after the analysis suggested a negative return. In the PRC, the low projected return may be due to high costs associated with new packaging and the intensive promotion of a new product. In Pakistan, where VAD prevalence in children is projected to decrease about 22%, the analysis shows about $4 returned for every 50%

\[ \text{TABLE 29: Projected Ten-Year Impacts of Vitamin A Fortification of Oil} \]

<table>
<thead>
<tr>
<th>VAD Prevalence</th>
<th>Potential Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre Fortification (%)</td>
<td>Post Fortification (%)</td>
</tr>
<tr>
<td>Indonesia</td>
<td>50</td>
</tr>
<tr>
<td>Pakistan</td>
<td>24</td>
</tr>
<tr>
<td>PRC</td>
<td>28</td>
</tr>
<tr>
<td>Totals</td>
<td></td>
</tr>
</tbody>
</table>

\[ \text{TABLE 30: Estimated Ten-Year Costs for Oil Fortification} \]

<table>
<thead>
<tr>
<th></th>
<th>Indonesia ($)</th>
<th>Pakistan ($)</th>
<th>PRC ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Production Costs</td>
<td>52,694,523</td>
<td>31,107,220</td>
<td>45,228,387</td>
</tr>
<tr>
<td>Marketing Costs</td>
<td>2,714,500</td>
<td>2,036,620</td>
<td>16,986,057</td>
</tr>
<tr>
<td>Food Control and Monitoring</td>
<td>2,507,157</td>
<td>2,689,170</td>
<td>5,149,572</td>
</tr>
<tr>
<td>Total Budget</td>
<td>60,371,960</td>
<td>35,833,010</td>
<td>67,364,016</td>
</tr>
</tbody>
</table>

\[ ^{49} \text{The large drop in deaths is due to very high initial prevalence of 50\% in children from 6- to 60-months old.} \]

\[ ^{50} \text{Based on stability tests at the University of Guelph under the guidance of the studies’ Principal Investigator, it was assumed for the CIP that 60\% added vitamin A was retained at the point of consumption.} \]
dollar of investment. Indonesia shows the best economic return, with a benefit-cost ratio of 11:1—an extremely attractive investment in protecting children and lowering the national burden of disease. The high baseline prevalence of VAD in Indonesian children, which reveals a real national health emergency, is a major factor in this favorable benefit-cost ratio. Table 31 summarizes the overall benefits and costs of oil fortification in Indonesia, Pakistan, and PRC.

Given the significant projected impact of oil fortification, why are the benefit-cost ratios relatively modest? In part because it is difficult, if not impossible, to assign a dollar value to the prevention of child mortality. In the CIPs, the value of a life saved is coldly calculated at 30 years times the average wage (discounted). This may not be sufficient. Moreover, although the program fortifies the oil consumed by the entire population, the benefits are only measured among children under 5 years of age. In other words, costs are incurred for national coverage while benefits are measured for only a tiny population segment. It should also be noted that emerging evidence suggests that vitamin A provided during pregnancy may have a significant impact on all causes of maternal mortality. Due to the lack of scientific consensus on this emerging data, the potential life-saving impact of vitamin A on women was not included in the analysis. Further, it should be noted that additional vitamin A supplied to children via a healthier mother’s breast milk was not calculated in the CIP analysis.

In summary, it may be that the conservative assumptions used in this analysis may not show vitamin A fortification in a “cost-effective” light. Other analyses, using other benchmarks, show vitamin A fortification to be very cost-effective. For example, the Latin American and Caribbean Health and Nutrition Sustainability Project of the US Agency for International Development (USAID) reviewed the relative cost and effectiveness of dietary diversification, supplementation, and sugar fortification in Guatemala. Sugar fortification with vitamin A was indicated to be from 3 to 8 times more cost-effective than the other interventions. Since oil fortification is much less costly than sugar fortification with vitamin A, it may well be that oil fortification will emerge as very cost-effective when compared with other life-saving interventions.

The following are the CIP summaries for the five Asian countries.

### Indonesia CIP Summary

Since the 1970s, health and nutrition programs to alleviate poverty have been an integral component of the Government of Indonesia’s Five-Year Development Plan. These programs played a significant part in reducing the prevalence of poverty from 60% in 1970 to 13.5% in 1996. Health indicators like the infant mortality rate improved from 145 to 46 per 1,000 live births. However, since the economic crisis of 1997, the number of families living in poverty has doubled to 27.4%. Health and nutrition indicators have also deteriorated. More than half the children under 5 years of age were vitamin A deficient in 2001. It is estimated that, with no improvements, mortality due to VAD will exceed 350,000 children over the next 10 years. The national prevalence of anemia exceeds 40% among both women and children, and maternal deaths due to anemia are expected to reach 44,000 over the next decade. Ten-year losses in productivity are projected at nearly $6 billion.

### Strategic Framework

The Indonesia CIP is based on Article 27 of Indonesia’s Food Law of 1996, which mandates food fortification programs to improve nutritional status. The National Fortification Commission, an official multisectoral body charged with developing national fortification strategies, is housed in the Coordinating Ministry of Economic Affairs. Emerging from a 2-year,
national, public-private consultative process, the Indonesia CIP affirms the need for government leadership in legislating mandatory regulations for the fortification of wheat flour, palm oil, and complementary foods. Major implementing government organizations involved in the CIP include the National Food Fortification Commission for management and operational issues; the Ministry of Industry and Trade for regulation, technology, and training; the National Agency for Drug and Food Control for program and market monitoring; and the Ministry of Health for social marketing and biological evaluation. Universities, research institutions, and relevant private sectors were integrally involved in the development of the CIP and, in some cases, will be involved in implementing the proposed activities. The CIP proposes integrated program management among all proposed fortification vehicles for cost-efficient enforcement and nutrition monitoring.

Wheat Flour Fortification

Wheat flour products, particularly noodles, are consumed regularly by approximately half of the Indonesian population. Most wheat is imported and milled at five large, modern facilities. Recognizing this opportunity to supply additional nutrients, the Government of Indonesia established regulations in 1998 mandating the fortification of all wheat flour. While the milling industry has generally supported fortification and complied with the regulation, the situation is fragile. The price of fortificant mix, set in US dollars, has soared since the Indonesian rupiah plunged in 1998. Moreover, weak communication and enforcement capacity resulted in a 20%–30% rise in the importation of less expensive and nonfortified flour. In this fluid situation, only the generous support of the Canadian International Development Agency and the USAID for a subsidy on micronutrient mix has enabled the program to continue.

The CIP proposes an integrated approach to addressing this unsustainable situation. First, capacity-building in food control and customs are needed to ensure that regulations are transparently enforced and that domestic and international flour competes on an equal footing. While food control for the few domestic millers is a relatively simple matter, the enforcement of imports at Indonesia’s many ports is more difficult. Second, the CIP proposes a social marketing campaign to raise awareness of the health benefits of fortified products and to protect the growing market share of flour products. And finally, as these programs take hold, the CIP proposes a declining 3-year subsidy to cushion the transition to market financing.

With only 45% of the population consuming flour on a consistent basis, it is difficult to quantify the impact of the flour fortification program. Based on estimates provided by the milling industry, the CIP estimates that two-thirds of flour consumers are from more affluent families. Only an estimated one-third of flour consumers are at high risk of anemia. Consequently, with limited coverage and conservative assumptions, anemia is projected to fall down to as much as 4% among flour consumers and as much as 2% on a national basis. However, given the cost-efficient industrial environment, the benefit-cost ratio for added iron and folic acid is 5:1.

Palm Oil Fortification

Indonesia is one of the world’s largest producers and exporters of coconut palm oil. Palm oil is inexpensive and widely consumed. There is little reported variation in intake among socioeconomic segments or between rural and urban populations. While other oils, such as coconut and soybean oil, are on the market, these account for less than 5% of purchased oil products and are usually premium products; they are not consumed by the at-risk populations. About 90% of families consume palm oil at least weekly, with an average intake of 21 grams per person per day. On average, fortification with 50 IUs (15 µg) of vitamin A per gram—even with an estimated retention of only 60% during distribution, storage, and cooking—can provide the consumer with approximately 25% of daily requirements.

With palm oil processing centralized in 57 processing plants, fortification is feasible and cost-efficient. While palm oil fortification is technically uncomplicated in the current processing environment, it has not been evaluated for effectiveness on a commercial scale. Therefore, a program of product development is proposed. This includes efficacy and effectiveness trials, to be followed by legislation mandating the fortification of cooking oils by 2006. The CIP projects a 3-year period for industrial phase-in to achieve 100% fortification.
at all facilities. The program will be supported by an extensive commercial and social marketing campaign conducted cooperatively by palm oil producers and their trade association, along with the Ministry of Health. The campaign will be integrated with health education, which will be delivered at the grassroots level through the health workers and NGOs.

Based on conservative projections of children consuming 25% of the average oil consumption of adults, the prevalence of VAD among this at-risk group is projected to fall about 20%. Over 10 years, this is projected to save more than 44,000 lives and more than $500 million\(^5\) in health care costs. The benefit-cost ratio is about 11:1.

**Complementary Foods Fortification**

Although fortification legislation for commercially produced complementary foods has been in place in Indonesia since 1995, consumption is low. While several government distribution programs for high-risk children have indicated acceptance of commercial complementary foods in poor and rural areas, these programs have not been sustainable. The CIP proposes a collaboration among Gizindo Foods (a domestic producer), DULOG (the national public food distribution agency), and the MOH to target 25% of Indonesia’s less affluent rural children aged 6–12 months. The program involves the production and distribution of approximately 3,800 MT of complementary foods annually—sufficient to provide 210,000 children with 50 grams per day.

Industry analysts in Indonesia note that access, price, and awareness are major barriers to the widespread commercial use of complementary foods. The public-private collaboration proposes to create a sustainable business model to address these barriers. First, ongoing trials are working to develop a less expensive product and packaging. Second, the CIP proposes simultaneously lowering distribution costs and increasing access among the rural poor via multiple and less expensive distribution lines. Along with conventional distribution and marketing, DULOG, which currently supplies the rural poor with subsidized rice, will use its provincial and district facilities, personnel, and capabilities to distribute fortified complementary foods. In addition to the DULOG network, complementary food products will be supplied to rural stores as well as directly to families via a network of MOH clinics and a grassroots organization of midwives. Third, the program will work to raise awareness and demand via traditional media, and via a targeted marketing campaign utilizing rural community radio, the DULOG and Ministry of Health networks, and the targeted opportunities provided by the midwives.

The proposed program provides fiscal incentives for the DULOG and local midwives with mark-ups of approximately 10%; this is less than commercial distributors, and it provides channels that reach deeper into rural areas. A revolving fund would provide midwife saleswomen with a free first month’s supply of the product. The CIP requests an initial grant of $350,000 for the completion of product development, as well as training and education for the rural workers in the DULOG and MOH network.

Table 32 summarizes the 10-year budget for each proposed project, the amount to be provided by the Government and through market channels, and the amount requested from donors.

**Pakistan CIP Summary**

Per capita incomes in Pakistan have tripled over the last 50 years. As a result, by the late 1980s, the proportion of the poor population had declined to 17.6% (though recent upheavals in the country have caused this figure to rise). However, there seems to have been no corresponding improvement in the nutritional status of the population. Half the children below 5 years of age are malnourished; of these, 40% are underweight, 50% are stunted, and 9% are wasted.

Iron deficiency is the most prevalent micronutrient problem in Pakistan. About 60% of pregnant and lactating women and two-thirds of children are anemic.\(^5\) The CIP analysis estimates that,

---

\(^5\) Again, Indonesia reports the highest reported VAD prevalence in children in the region (over 50%). This figure for projected health care costs saved remains under review.
### TABLE 32: Costs of Proposed Fortification Projects for Indonesia, and the Amount Requested from Donors

<table>
<thead>
<tr>
<th>Wheat Flour Production Costs</th>
<th>Ten-Year Budget ($)</th>
<th>Government Share ($)</th>
<th>Market Share ($)</th>
<th>Seed Financing Request ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Premix and Recurring Costs</td>
<td>15,495,700</td>
<td>2,304,705</td>
<td>12,291,760</td>
<td>768,235</td>
</tr>
<tr>
<td>Capital and Equipment</td>
<td>131,000</td>
<td>131,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Subtotal</strong></td>
<td><strong>15,626,700</strong></td>
<td><strong>2,304,705</strong></td>
<td><strong>12,422,760</strong></td>
<td><strong>768,235</strong></td>
</tr>
</tbody>
</table>

| Public Functions            |                     |                      |                  |                           |
| Food Control Costs          | 464,579             | 232,290              |                  |                           |
| Biological Monitoring       | 2,042,578           | 2,042,578            |                  |                           |
| Social Marketing            | 2,714,500           | 904,833              | 1,809,667        |                           |
| **Subtotal**                | **5,221,657**       | **2,304,705**        | **3,916,867**    | **4,084,535**             |

| **Total**                   | **20,586,387**      | **2,536,995**        | **16,040,393**   | **4,852,770**             |
| **% of Total Budget**       | 12%                 | 64%                  | 24%              |                           |

| Cooking Oil Production Costs |                     |                      |                  |                           |
| Product Development         | 500,000             | 500,000              |                  |                           |
| Premix and Recurring        | 50,769,325          | 7,615,399            | 38,076,994       | 5,076,933                 |
| Capital and Equipment       | 1,425,198           | 213,780              | 1,068,418        | 142,520                   |
| **Subtotal**                | **52,694,523**      | **8,842,579**        | **39,145,892**   | **5,269,453**             |

| Public Functions            |                     |                      |                  |                           |
| Food Control Costs          | 1,713,254           | 1,713,254            |                  |                           |
| Biological Monitoring       | 535,183             | 535,183              |                  |                           |
| Social Marketing            | 5,429,000           | 5,429,000            |                  |                           |
| **Subtotal**                | **7,677,437**       | **7,677,437**        |                  |                           |

| **Total**                   | **60,371,960**      | **7,829,179**        | **39,145,892**   | **13,396,889**            |
| **% of Total Budget**       | 13%                 | 65%                  | 27%              |                           |

| Complementary Foods         |                     |                      |                  |                           |
| Start-Up Costs              | 250,000             | 250,000              |                  |                           |

| Recurring Production Costs  |                     |                      |                  |                           |
| 3825.5 MT Complementary     |                     |                      |                  |                           |
| Fortified Food              |                      |                      |                  |                           |
| **45,990,000**              | **11,497,500**      | **27,594,000**       | **6,898,500**    |                           |

| Food Control and Biological Monitoring Costs | | | |
| Food Control                   | 193,240             | 193,240              |                  |                           |
| 1/6 of Integrated Epidemiological Surveillance | 130,500             | 130,500              |                  |                           |
| **Subtotal**                   | **323,740**         |                      |                  |                           |

| Marketing Costs               |                     |                      |                  |                           |
| Distribution (DULOG)          | 4,599,000           | 4,599,000            |                  |                           |
| Midwife/Sales Mark-Up        | 5,518,800           | 5,518,800            |                  |                           |
| Social Marketing Trainings    | 4,149,000           | 4,149,000            |                  |                           |
| Social Marketing Materials    | 6,021,200           | 6,021,200            |                  |                           |
| Revolving Fund for Local Midwives | 286,000             | 286,000              |                  |                           |
| **Subtotal**                   | **20,574,000**      | **10,117,800**       | **10,456,200**   |                           |

| **Total**                     | **67,137,740**      | **11,497,500**       | **37,711,800**   | **17,928,440**            |
| **% of Total Budget**         | 17%                 | 56%                  | 27%              |                           |
as a result of this high prevalence, Pakistan suffers 18,000 maternal deaths and $4.2 billion in productivity losses annually.

In WHO’s 1994 classification of countries by level of vitamin A deficiency, Pakistan is in the severe subclinical category, i.e., countries needing urgent attention. Surveys estimate individual dietary intake of vitamin A at 62% of the RDI for females and 76% for males. Biochemical analysis shows a VAD prevalence of 24% among children under age 5. A study by Aga Khan University Hospital in 1990 of children from low-income families demonstrated marginal vitamin A deficiency in almost half the children examined. VAD, in combination with high rates of infectious disease and limited access to health care, puts these children at high risk of dying before their 5th birthday. Computer models indicate more than 43,000 child deaths a year and several billion dollars in annual health care costs to the economy as a result of this high rate of VAD.

**Fortification of Wheat Flour**

Wheat is the staple food of Pakistan. The reported average per capita monthly consumption of wheat flour is 9.27 kilograms (kg). In rural areas, it is 10.11 kg and, in urban areas, it is 7.23 kg. Consumption is relatively constant across income classes—the per capita monthly consumption of flour by the poorest segments of the society is 9.2 kg, and of the richest, 9.1 kg. Wheat flour fortified with 60 parts per million (ppm) iron and 1.5 ppm folic acid is currently being produced at two mills in Peshawar for the World Food Program (Afghanistan). Currently, three mills in various regions of Pakistan are conducting market trials and testing for optimally acceptable and bioavailable iron compounds.

The technical environment for fortification at Pakistan’s large-scale roller mills, which produce 50% of Pakistan’s flour, is positive. This flour is processed at 690 roller flourmills with a total grinding capacity of more than 113,000 tons per day. These mills are organized into a national association. The remaining milling is at a large and undetermined number of small-scale chakki mills. Although research into fortification at chakki mills is ongoing, strategies for commercial sustainability have yet to be established. The relative distribution of flour products made from chakki mills versus the larger formal sector has not been extensively surveyed, but these small mills are estimated to produce more than half of the nation’s flour.

The Pakistan Country Team proposes a 5-year plan to complete product development and mandate and expand flour fortification on a phased basis throughout the large-scale sector. Capital and startup costs are estimated at $24 million. Ten-year costs for public-sector capital investment and capacity-building in food control and regulatory institutions, as well as social marketing campaigns, are estimated at $4–5 million over 10 years. The cost of micronutrient mix and other recurring costs are estimated to run approximately $137 million over 10 years. Given the current market environment and the competitive situation of roller-milled versus chakki flour, temporary premix subsidies—declining over 5 years—are envisioned.

**Vegetable Ghee and Edible Oil**

The enrichment of vegetable ghee with vitamin A was legislated in 1965, but most manufacturers have not adhered to fortification standards. A survey of 80 industrial units in 1993 found vitamin A in vegetable ghee/oil to be only 40% of the required level. Monthly per capita consumption of vegetable ghee is high at 0.65 kgs, and is almost constant across urban and rural populations. While in rural settings low-income groups consume less than the average, the urban poor consume 150% of the average of the highest-income group. With current technologies and Pakistani storage, distribution, and cooking conditions, these levels of consumption are sufficient to deliver nearly 20% of RDI to the lowest-income rural consumers. There are about 130 vegetable ghee and 52 solvent extraction plants.

The benefits of fortification have been estimated to be quite substantial: 42,000 lives saved and economic benefits of $120 million over a 10-year period as a result of vitamin A fortification. The total 10-year cost of oil fortification as proposed by Pakistan is approximately $37 million.

55 Revised figures may put this at closer to 1,000 mills.

56 Vegetable ghee is a clarified, semifluid vegetable oil product.
Innovative public-private collaboration to address transparent regulation and enforcement is required. The Government’s performance in enforcing existing fortification standards for vegetable ghee does not yet inspire confidence in its ability to manage a much wider food fortification program. The Country Team proposes reducing reliance on the Government by developing an independent regulatory mechanism that will result from collaboration between the public and private stakeholders. The development process will try to build on the experience of other countries and shall adopt their best practices. Ample technical assistance can be solicited from the international community. No costs are currently included for this collaborative mechanism, as the concept is still in development.

Table 33 summarizes the 10-year budget for each proposed fortification project, the amount to be provided by the Government and through market channels, and the amount requested from donors.

During the past 15 years, national strategies to ensure food security and alleviate poverty have had positive impacts on nutritional status throughout the PRC. However, a predominantly plant and cereal-based diet, particularly among the poor, means continued low intake of key micronutrients. Anemia among adult women in urban areas remains a public health problem, given a prevalence rate of 27.5%. In rural areas, IDA prevalence is 41%. In the PRC’s western provinces, IDA is projected to depress economic activity by $1.5 billion over 10 years. In these provinces, VAD also remains a public health problem. While life-threatening vitamin A deficiencies in children have been reduced to less than 20% among all children under 5 years old nationally (the threshold for public health concern), the prevalence of VAD in the five western provinces ranges far above 20%, reaching 42% in some areas.

### TABLE 33: Costs of Proposed Fortification Projects for Pakistan, and the Amount Requested from Donors

<table>
<thead>
<tr>
<th>Project</th>
<th>Ten-Year Budget ($)</th>
<th>Government Share ($)</th>
<th>Market Share ($)</th>
<th>Financing Request Seed ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Wheat Flour</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Capital and Start-Up Costs</td>
<td>23,824,000</td>
<td>6,152,000</td>
<td>12,800,000</td>
<td>4,872,000</td>
</tr>
<tr>
<td>Recurring Production Costs</td>
<td>137,043,730</td>
<td>41,113,119</td>
<td>68,521,865</td>
<td>27,408,746</td>
</tr>
<tr>
<td>Food Control and Biological Monitoring Costs</td>
<td>2,689,170</td>
<td></td>
<td>2,689,170</td>
<td>2,036,620</td>
</tr>
<tr>
<td>Marketing Costs</td>
<td>2,036,620</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>165,593,520</td>
<td>47,265,119</td>
<td>81,321,865</td>
<td>37,006,536</td>
</tr>
<tr>
<td>% of Total Budget</td>
<td>29%</td>
<td>49%</td>
<td>22%</td>
<td></td>
</tr>
<tr>
<td><strong>Cooking Oil</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Recurring Production Costs</td>
<td>31,107,220</td>
<td>6,221,444</td>
<td>21,775,054</td>
<td>3,110,722</td>
</tr>
<tr>
<td>Capital and Start-Up Costs</td>
<td>2,689,170</td>
<td></td>
<td>2,689,170</td>
<td></td>
</tr>
<tr>
<td>Food Control and Monitoring Costs</td>
<td>2,036,620</td>
<td></td>
<td>2,036,620</td>
<td></td>
</tr>
<tr>
<td>Marketing Costs</td>
<td>2,036,620</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>35,833,010</td>
<td>6,221,444</td>
<td>21,775,054</td>
<td>7,836,512</td>
</tr>
<tr>
<td>% of Total Budget</td>
<td>17%</td>
<td>61%</td>
<td>22%</td>
<td></td>
</tr>
</tbody>
</table>
The PRC CIP focuses on initially addressing micronutrient malnutrition in rural and less-affluent regions. The Country Team's consumption analysis indicates that wheat flour and soy sauce are the most plausible populationwide vehicles. The plan works through two broad strategies: improving industrial capacity and product quality, and building affordable distribution channels to the poor.

The experience of the past decade indicates that, as the PRC's economy grows, consumers are eager to move to higher-quality products that improve their lives. The CIP builds on these changing market trends and consumer preferences. The strategy focuses on the expansion and centralization of the PRC's food processing industry into more efficient production units delivering higher-quality foods—foods that are safer, more hygienic, and more nutritious. This includes adopting industry standards such as HACCP, GMP, and Sanitation Standard Operating Procedures (SSOP), as well as, in parallel, building effective government food regulation and control. The plan works to simultaneously address micronutrient deficiencies, meet consumer preferences for higher-quality foods, and strengthen public and private capacity for product quality assurance.

The CIP recognizes that economic development is not always even-handed and sometimes leaves behind those most in need. Therefore, a second key component of the strategy presented in the CIP is to build operational links to established poverty reduction programs and create partnerships with institutions offering channels to the poor. The focus for several food vehicles is piloting and expansion in the western region, where poverty reduction agreements with many donors, such as ADB, are concentrated. A key component in all of the proposed programs is distribution and social marketing to provide access and often lower pricing for low-income and rural populations. Requested support from international sources is specifically geared to accelerating the penetration of fortified products among the poor and at-risk. The CIP projects that the more upscale commercial markets will sustain themselves without public support.

**Soy Sauce Fortification**

Soy sauce is consumed by nearly 80% of households in the PRC at an average consumption of 12.6 milliliters (ml) per person per day, and at nearly 11 ml per person per day in rural areas. Industry consolidation over the past decade has resulted in 200 large firms producing 42% of total soy sauce output. This process of consolidation is expected to continue. Industrial and market trials have determined that these large production facilities can easily adopt fortification technology. Production is ongoing, and limited quantities of fortified products are already available, albeit restricted to more affluent consumer markets.

The PRC Ministry of Health's Centers for Disease Control and other public agencies, together with the China Soy Sauce Manufacturers Association, have agreed on a collaborative plan to engage the nation's 200 major firms with a variety of incentives to fortify. These include a marketing campaign, a fortification logo, and access to special markets and distribution channels targeting rural areas. A partial subsidy for fortificant will be provided to companies that participate in the earlier years of the program. The 5-year plan aims to expand from 10 producers in year 1 to 200 in year 5, resulting in the fortification of 36% of total national output by 2008.

Ultimately, this program is expected to reach up to 500 million consumers nationally, including 250 million in targeted northwest provinces and as many as 129 million women and children at high risk of anemia. Based on large-scale effectiveness trials with soy sauce fortified with NaFeEDTA, which have found prevalence reductions of more than 50%, it is anticipated that anemia will be reduced by one-third among consumers of this product. Ten-year benefits in increased productivity emerging from the prevention of anemia are projected at more than $2.25 billion. The CIP estimates a benefit-cost ratio of 9:1.

**Wheat Flour Fortification with Multiple Micronutrients**

While in most of the PRC rice is the major staple food, people living in the northern and western regions of
the country consume wheat flour products as their major staple. Surveys report average daily wheat consumption of 200–400 grams per day in this region. And in targeted low-income provinces, consumption among the poor is equal to or greater than consumption among the more affluent. Therefore, wheat flour provides an opportunity to target fortification to those most at-risk in these areas and to reduce iron and other micronutrient deficiencies substantially.

Large-scale product development and biological effectiveness trials for fortified wheat are currently underway. Upon completion of these trials, the CIP proposes a three-phase expansion. In the first phase, all flour in a public distribution program targeting some 91 million consumers in five western provinces will be fortified. In the second phase, the program will be expanded to the commercial market for all 12 western provinces, thereby reaching more than 250 million people. This phase involves upgrading the milling industry in the western PRC from predominantly small enterprises to large-scale, efficient mills. This transition to larger-scale production will be driven by investments in production upgrades, local legislation, regulatory incentives (including a market-access license system), and a major marketing and education campaign. As new production and distribution systems are built and consumers recognize the benefits of the higher-quality and more nutritious flour products, the enforcement of new regulations will be extended incrementally to phase out smaller mills. The final phase includes expansion to a comprehensive national program.

External financing assistance is requested for market development and communications, the extension of distribution systems, the costs of industry consolidation, and the development of quality assurance mechanisms and regulatory procedures. Some subsidies for the lowest-income consumers as well as start-up modifications for the milling industries will be offered on a short-term basis.

At 300 grams per day, with the specified fortification levels, average flour consumption will provide 100% of the RDA of iron; this high amount is needed due to the low iron bioavailability in the diets of people living in the western PRC. The CIP projects that this added intake will reduce IDA prevalence by 15%, avert more than 32,000 deaths over 10 years, and result in more than $500 million in increased productivity and health care cost savings.

**Complementary Foods**

The lack of adequate nutrition, including required micronutrients, among children from 6- to 36-months old is the most serious form of malnutrition found in the PRC today. Commercially processed, fortified complementary foods provide an opportunity to improve this tragic situation. In the PRC’s poorest provinces, 9–25% of children aged 9–12 months receive some commercially purchased complementary food. This indicates accessibility, awareness, and perceived value. However, price remains a major obstacle to sustained use. The PRC Country Team’s analysis of the pricing structure for commercial complementary foods indicates that 50% of the current high price of this product is due to the costs of marketing, distribution, and overhead/profit. Therefore, the premise of this proposal is that substantial price reductions are possible via a public-private partnership in which generic versions are purchased, distributed, and marketed through public channels. Both Heinz and Nestlé have indicated their interest in a partnership for producing alternative, generic fortified products for consumers in western rural areas.

Building on a current maternal and child health outreach project covering 40 counties across five provinces of the northwest PRC, the Ministry of Health and UNICEF propose a market trial of this concept. The population of children under 3 years old in 12,000 villages in this region is approximately 750,000. Agreements to assist in distribution and promotion are being reached with a number of local and provincial government agencies and NGOs, as well as private distribution and retail outlets. The CIP proposes to reach 20% of the 6- to 36-month olds in these 40 counties in the first year of the program and scale up to 50% by year 5. If successful, the partners will propose expanding across the whole northwest province area. While most production and distribution costs will be borne by the Government and the market, donor support is requested for a 5-year marketing campaign. The estimated cost is $5 million, including an initial $500,000 for feasibility and project development and $100,000 annually for
marketing and distribution activities in each of nine western provinces. A second strategy based on the “in-home fortification” of complementary foods is under development. Table 34 summarizes the 10-year budget for each proposed fortification project, the amount to be provided by the Government and through market channels, and the amount requested from donors.

**Thailand CIP Summary**

With prevalence rates ranging from 15% to 25%, iron deficiency anemia is projected to depress the Thai economy by more than $200 million annually. Over 10 years, deaths attributed to lack of folic acid—via birth defects and coronary heart disease (CHD)—are conservatively estimated at approximately 1,000 annually. And many of the 36,000 CHD cases reported in Thailand each year, which cost the nation $15 million annually, could be prevented with additional folic acid in the diet.

**Strategic Framework: The Thai Nutrition Seal**

The Thai Nutrition Seal program is a public-private collaboration to create a comprehensive communication, advocacy, and quality assurance program that will stimulate demand for and awareness of fortified products among consumers and motivate producers to fortify. The Nutrition Seal, which includes a graphic logo denoting the official approval of the Thai Ministry of Public Health (MOPH), will be offered specifically to companies involved in the production of fortified foods that the MOPH considers accessible to rural, poor, and at-risk populations. Initially this includes three food vehicles: fish sauce fortified with iron, wheat flour with multiple vitamins and minerals, and precooked ground rice as an inexpensive complementary food for children aged 6–12 months. The Nutrition Seal program will conduct market research and implement logo recognition campaigns and other promotions using traditional media channels as well as in coordination with public institutions such as schools, the MOH, and NGOs. In addition, the launch of each fortified product line, such as fish sauce or wheat flour, will be coordinated with a generic, vehicle-specific marketing campaign. Nutrition Seal marketing programs will be coordinated by the MOPH but implemented via a subcontract to an advertising and marketing agency. The program includes a quality assurance component involving routine food analysis, which will be subcontracted to private laboratories. This cooperative public-private approach to quality assurance and consumer protection may provide a model for other programs. Though ambitious, this voluntary and market-driven approach is considered realistic in Thailand given the history of close collaboration between the MOPH and the private sector.

**Fortification of Fish Sauce with Iron**

Recent trials at Mahidol University and fish sauce processing facilities have indicated the feasibility and consumer acceptability of fish sauce with added iron (in the form of ferrous sulfate), along with citric acid as a chelating agent. Fish sauce is widely consumed among all socioeconomic classes at an average of 15 ml per day. Production facilities are modern and centralized, with 20 producers holding 80% of the market. Therefore, fish sauce is considered a feasible vehicle for delivering additional iron to the vast majority of the Thai population, including those at risk. Fortification sufficient to deliver 33% of the RDA for iron at average consumption level is estimated to cost 0.31 cents per 750 ml bottle. The CIP proposes expanding fortification to 100% of fish sauce produced at the 20 largest plants over 4 years.

In addition to ongoing Nutrition Seal promotions, an intensive 3-year generic marketing and media campaign is planned in conjunction with the Fish Sauce Producers Association. The Thailand CIP proposes incentives for participation such as a fortification subsidy for producers participating in the early years of the program. IDA rates are estimated to fall 8-10% through this intervention. Ten-year reductions in economic losses are projected at $160 million.

**Wheat Flour Fortification with Iron and Folic Acid**

Consumption of wheat flour in Thailand has grown steadily. Eight large, modern plants currently have the capability for fortification, and can adopt fortification technology quickly and efficiently. It is considered feasible as well as inexpensive to implement fortification and assure quality. The CIP projects that
<table>
<thead>
<tr>
<th>Wheat Flour</th>
<th>Government Share</th>
<th>Market Share</th>
<th>Seed Financing Request</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Recurring Production Costs</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Facilities and Equipment</td>
<td>10,000,000</td>
<td>10,000,000</td>
<td></td>
</tr>
<tr>
<td>Laboratory Equipment</td>
<td>41,950,000</td>
<td>1,650,000</td>
<td>36,400,000</td>
</tr>
<tr>
<td>Q/A System (HAACP, GMP, SSOP)</td>
<td>2,500,000</td>
<td>2,500,000</td>
<td></td>
</tr>
<tr>
<td><strong>Subtotal</strong></td>
<td>54,450,000</td>
<td>1,650,000</td>
<td>3,900,000</td>
</tr>
<tr>
<td><strong>Capital and Start-Up Costs</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Food Control and Biological Monitoring Costs</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Training</td>
<td>900,000</td>
<td>792,000</td>
<td>108,000</td>
</tr>
<tr>
<td>Nutrition Monitoring</td>
<td>70,000</td>
<td>70,000</td>
<td></td>
</tr>
<tr>
<td>Food Control</td>
<td>1,224,000</td>
<td>1,224,000</td>
<td></td>
</tr>
<tr>
<td><strong>Subtotal</strong></td>
<td>2,194,000</td>
<td>792,000</td>
<td>1,402,000</td>
</tr>
<tr>
<td><strong>Marketing Costs</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Social Marketing/Seal</td>
<td>26,400,000</td>
<td>8,200,000</td>
<td>14,800,000</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>184,125,100</td>
<td>9,850,000</td>
<td>165,573,100</td>
</tr>
<tr>
<td>% of Total Budget</td>
<td>5%</td>
<td>90%</td>
<td>5%</td>
</tr>
</tbody>
</table>

| Soy Sauce                                       |                  |              |                        |
| **Recurring Production Costs**                  |                  |              |                        |
| Fortificant                                     | 198,030,000      | 450,000      | 196,980,000            |
| Plant Operations (HAACP, GMP, SSOP)             | 15,750,000       | 350,000      | 15,050,000             |
| **Subtotal**                                    | 213,780,000      | 800,000      | 212,030,000            |
| **Capital Costs**                               |                  |              |                        |
| Production and Q/C Analysis Equipment           | 5,625,000        |              | 262,000                |
| **Food Control and Biological Monitoring Costs**|                  |              |                        |
| Legislation and Advocacy                        | 20,000           |              |                        |
| Social Marketing/Seal                           | 15,913,000       | 500,000      | 14,150,000             |
| **Subtotal**                                    | 15,933,000       | 520,000      | 1,263,000              |
| **Total**                                       | 240,238,000      | 5,624,000    | 231,543,000            |
| % of Total Budget                               | 2%               | 96%          | 1%                     |

| Complementary Foods                             |                  |              |                        |
| **Recurring Production Costs**                  |                  |              |                        |
| Recurring Costs                                 |                  |              |                        |
| Fortificant                                     | 3,144,600        | 64,000       | 3,064,600              |
| Plant Operations (HAACP, GMP, SSOP)             | 275,000          | 80,000       | 145,000                |
| **Subtotal**                                    | 3,419,600        | 144,000      | 3,209,600              |
| **Capital Costs**                               |                  |              |                        |
| Q/A Analysis Equipment                          | 160,000          |              | 50,000                 |
| **Food Control and Biological Monitoring Costs**|                  |              |                        |
| Legislation and Advocacy                        | 1,943,170        |              | 46,170                 |
| Social Marketing/Seal                           | 8,800,000        | 2,800,000    | 1,000,000              |
| **Subtotal**                                    | 9,643,170        |              | 5,800,000              |
| **Total**                                       | 14,322,770       | 4,841,000    | 4,319,600              |
| % of Total Budget                               | 34%              | 30%          | 36%                    |
all eight plants will fortify 10% of their production during the first year of the program, reaching 50% in the second year, and 100% in year 3. Since flour is mainly an industrial rather than consumer product, a modest, one-year public education campaign is planned via the Nutrition Seal program.

While the Thai population, particularly the most at-risk in poor and rural areas, predominantly consumes rice, consumption surveys indicate that more than 11% of the rural, low-income population consumes an average of 30 grams per day of flour products. Thirty percent of the low-income urban population consumes more than 70 grams per day. At these consumption levels, fortification with 60 ppm iron and 2 ppm folic acid can deliver an average of 10-30% of RDA for both micronutrients. Prevalence reduction is estimated at about 2%, suggesting 10-year savings of more than $13 million in current and future productivity lost to IDA. Given the low cost of wheat flour fortification, these reductions show a benefit-cost ratio of nearly 5:1.

Rice-Based Complementary Food

In Thailand, foods for children aged 6–12 months are mostly home-prepared, rice-based foods. These products are known to be low in key vitamins and minerals. A commercial preparation of dried, ground rice is increasingly popular among low- to medium-income populations due to time saved in preparation.

Using available technology, Mahidol University, along with a major producer, has successfully fortified this product with multiple micronutrients, including calcium, iron, vitamin B₁, and folic acid. The production technology is simple and can be easily adapted by related industries. The incremental cost for micronutrient premix, as well as energy, labor, and new packaging, is estimated at $0.004 per package or about $0.036 per child per year. The producer currently preparing to launch this product can supply 10% of children ages 6–12 months who are currently fed commercial complementary foods, a total of about 25,000 children. With advocacy and social marketing via the Nutrition Seal program, it is expected that within 5 years an additional five companies will enter this market, enabling the fortified product to reach 250,000 infants (50% of the low- to medium-income 6- to 12-month olds). Alternatively, the current producers may expand production facilities to increase market share. Given the need to increase supply and generate demand for a new line of product, the Nutrition Seal marketing campaign in support of this product will be relatively intense (for this narrow market) and will continue over a number of years.

Table 35 summarizes the 10-year budget for each proposed fortification project, the amount to be provided by the Government and through market channels, and the amount requested from donors.

Viet Nam CIP Summary

Indicators of health and wealth often rise and fall in tandem. In Viet Nam, however, despite a per capita GDP of only $410, many health indicators are much better than might be expected. This is in part due to government investment in and successful implementation of public health programs. For example, overall child mortality has dropped to 30/1,000 live births, much lower than most countries with comparable per capita incomes.

In large part, this low child mortality rate is due to the distribution of vitamin A capsules, which lowered VAD among children to 22%. Micronutrient deficiencies remain a severe public-health problem in Viet Nam, however. VAD still accounts for 4,000–5,000 child deaths annually. The national prevalence of anemia in women and children remains alarmingly high at 40–50%. As a consequence, nearly 16,000 women are expected to die in childbirth due to anemia-related complications over the next 10 years. With no improvement, current and future productivity losses attributable to IDA will mount to $150 million annually. The CIP focuses on anemia reduction through iron fortification of several food vehicles.

Strategic Approach

The National Strategy for Nutrition, ratified by Viet Nam’s Prime Minister on 22 February 2001, affirmed food fortification as an important measure to control micronutrient malnutrition and contribute to poverty reduction and human resource development. The stated goal is to provide 30% of the RDA for vitamin A and iron to at-risk households via fortified foods by 2012. A National Food Fortification Steering
Committee has been established under the leadership of the Ministry of Health, with technical coordination by the National Institute of Nutrition. The committee recognizes that, to advocate and plan for food fortification, it is essential to establish mechanisms to legally control the process. Therefore, the CIP proposes building national food regulatory and control structures as well as nutrition surveillance and monitoring systems. These functions will be coordinated by the newly established MOH Food Control Authority in conjunction with local Preventive Health Centers and other government ministries, as well as municipal governments and communes. Technical and operational support will be provided by the NIN. The committee is developing a series of supportive policies and regulations, including the elimination of a 30% duty that currently applies to imported micronutrient mixes.

**Fish Sauce**

Fish sauce is consumed by more than 80% of Vietnamese. High consumption among lower socioeconomic groups—averaging more than 8 ml per day—indicates that fortification with iron can deliver a significant portion of the RDA to populations at risk of anemia. With 70% of the production centralized in 30 large facilities—many controlled or partially owned by the Ministry of Fisheries—fortification is considered technically feasible and
cost-effective. The CIP outlines a 3-year phased plan to fortify all medium- and low-quality fish sauce produced at these large plants. Premium-quality fish sauce, with a 50-100% higher retail price, will not be part of the program. As Viet Nam's food-quality and safety systems are implemented, 200 or more smaller fish sauce operations will be upgraded and/or consolidated with the larger operations. Consequently, the market share of fortified fish sauce is projected to rise from 70% to 90% by the 10th year of the investment plan.

Product development and testing have been systematic. Early trials indicated that traditional iron forms were organoleptically unacceptable in fish sauce. The compound NaFeEDTA, newly approved by the Joint FAO/WHO Expert Committee on Food Additives, was found to perform well in fish sauce. A 1998 field survey found that factories could add NaFeEDTA to fish sauce with only minor process modifications. NaFeEDTA offers at least twice the bioavailability of traditional iron compounds, particularly in the cereal- and legume-based diets of the poor. In fact, in large-scale market trials of more than 14,000 consumers, NaFeEDTA reduced anemia by 50%. Consumer reaction is positive and acceptance has been demonstrated. In 2002, the Ministry of Health in Viet Nam approved NaFeEDTA as a food additive. The MOH, in conjunction with the Ministry of Fisheries and private producers, proposes to mount an extensive marketing campaign. Conservatively projecting a conservative 25% decline in the prevalence of anemia (half that achieved in the effectiveness trials), 10-year gains in current and future productivity should surpass $250 million, indicating a benefit-cost ratio of nearly 12:1.

Complementary Foods

Surveys indicate that, due to limited availability and high cost, only 5-10% of low-income rural Vietnamese children consume processed complementary foods. Anemia rates among this vulnerable group are often more than 60%. While there is no large-scale domestic production of complementary foods in Viet Nam, a pilot program in three rural communities has demonstrated the technical and commercial feasibility of producing fortified complementary foods at the community level. The pilot program is run by rural entrepreneurs with assistance from NIN, the Viet Nam Women's Union, and the French NGO Institute de Recherche Pour le Development. The production of Favina, a complementary food product discussed previously, utilizes simple extrusion technologies and locally purchased soybeans, rice, and other materials. The NIN and IRD train local personnel, assure product quality, and supply micronutrient mix, packaging, and education and marketing materials. Distribution through rural commercial outlets is complemented by an innovative home-visit sales program coordinated through the VWU. Favina has proven acceptable to the target population in terms of taste, preparation, packaging, and, most significantly, price. Sales have been sufficient to provide an attractive profit for producers and supplementary income for the VWU rural sales force. Preliminary biological evaluation by the IRD and the NIN indicate that anemia rates are cut by more than half. Data for other micronutrient deficiencies are not yet available.

Based on these product and market development activities, the CIP outlines a 10-year program of expansion to 97 production lines at 50 production sites strategically located in rural areas of Viet Nam. These would be sufficient to produce 8,500 MT of the product annually and reach 15% of the most at-risk rural 6- to 24-month olds, or approximately 360,000 children annually. The VWU is committed to marshalling local investment and providing their volunteer infrastructure as a grassroots sales force.

In addition to providing critical nutrients to the most vulnerable 6- to 24-month-old age group, the program is attractive to a number of national stakeholders because it targets high-risk poverty areas, provides a commercial outlet for local agricultural products, and creates entrepreneurial opportunities at the grassroots level. Therefore, contributions from government agriculture, rural employment, and poverty reduction programs are anticipated. Costs are estimated at $44 million, with another $22 million for the purchase of raw materials.

Wheat Flour

Since 1996, wheat flour consumption in Viet Nam has risen nearly 1,000%, from 79,000 MT to more than 700,000 MT annually. While average per capita consumption remains relatively low, a recent survey
in low-income, rural areas shows that 10–20% of women and children consume 100-140 grams per day of wheat products—sufficient to provide an additional 6-8 mg per day of iron (fortified at 60 ppm). Fortification is feasible in 16 relatively large and modern mills. While flour fortification is relatively inexpensive to implement, the narrow consumption profile yields limited but still significant impact. The CIP’s impact analysis suggests anemia prevalence decreases of 6-7% among wheat consumers and about 2% nationwide. These small decreases are sufficient to prevent more than $35 million in productivity losses over 10 years. Savings in health care costs from reduced birth defects and heart diseases as a result of additional folic acid intake were estimated at an additional $2 million. Given the low cost of flour fortification in Viet Nam, estimated at less than half a million dollars annually, the benefit-cost ratio is approximately 9:1. Given this positive projection, the National Fortification Steering Committee requests $150,000 to initiate the legally mandated process for efficacy trials to move toward the national fortification of wheat flour at levels recommended at ADB's Regional Workshop on Flour and Cooking Fortification (November 2001).

Table 36 shows the 10-year budget for each proposed project, the amount to be provided by the Government and through market channels, and the amount requested from donors.
TABLE 36: Costs of Proposed Fortification Projects for Viet Nam, and the Amount Requested from Donors

<table>
<thead>
<tr>
<th></th>
<th>Ten-Year Budget ($)</th>
<th>Government Share ($)</th>
<th>Market Share ($)</th>
<th>Seed Financing Request ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Wheat Flour</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Fish Sauce</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Production Costs</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Capital and Equipment</td>
<td>884,000</td>
<td>707,200</td>
<td>176,800</td>
<td></td>
</tr>
<tr>
<td>Premix and Recurring Costs</td>
<td>15,450,000</td>
<td>3,090,000</td>
<td>10,815,000</td>
<td>1,545,000</td>
</tr>
<tr>
<td><strong>Subtotal</strong></td>
<td>16,334,000</td>
<td>3,090,000</td>
<td>11,522,200</td>
<td>1,721,800</td>
</tr>
<tr>
<td><strong>Public Functions</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Food Control Costs</td>
<td>1,753,000</td>
<td>876,500</td>
<td>876,500</td>
<td></td>
</tr>
<tr>
<td>Nutrition Monitoring</td>
<td>410,000</td>
<td>410,000</td>
<td>410,000</td>
<td></td>
</tr>
<tr>
<td>Social Marketing</td>
<td>3,243,000</td>
<td>1,081,000</td>
<td>1,081,000</td>
<td>1,081,000</td>
</tr>
<tr>
<td><strong>Subtotal</strong></td>
<td>5,406,000</td>
<td>1,957,500</td>
<td>1,081,000</td>
<td>2,367,500</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>21,740,000</td>
<td>5,047,500</td>
<td>12,603,200</td>
<td>4,089,300</td>
</tr>
<tr>
<td>% of Total Budget</td>
<td>23%</td>
<td>58%</td>
<td>19%</td>
<td></td>
</tr>
<tr>
<td><strong>Complementary Foods</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Capital and Start-Up Costs</td>
<td>1,230,280</td>
<td>738,168</td>
<td>492,112</td>
<td></td>
</tr>
<tr>
<td><strong>Recurring Production Costs</strong></td>
<td>34,626,639</td>
<td>1,731,332</td>
<td>31,163,975</td>
<td>1,731,332</td>
</tr>
<tr>
<td><strong>Food Control and Biological Monitoring Costs</strong></td>
<td>805,000</td>
<td>805,000</td>
<td>805,000</td>
<td></td>
</tr>
<tr>
<td>Start-Up Training for VWU</td>
<td>2,388,420</td>
<td>1,194,210</td>
<td>1,194,210</td>
<td></td>
</tr>
<tr>
<td>Annual Marketing</td>
<td>4,587,014</td>
<td>458,701</td>
<td>1,834,805</td>
<td>2,293,507</td>
</tr>
<tr>
<td><strong>Subtotal</strong></td>
<td>6,975,434</td>
<td>1,652,911</td>
<td>1,834,805</td>
<td>3,487,717</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>43,637,353</td>
<td>3,384,243</td>
<td>33,736,948</td>
<td>6,516,161</td>
</tr>
<tr>
<td>% of Total Budget</td>
<td>8%</td>
<td>77%</td>
<td>15%</td>
<td></td>
</tr>
<tr>
<td><strong>Wheat Flour</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Production Costs</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Premix and Recurring Costs</td>
<td>2,448,510</td>
<td>2,326,085</td>
<td>122,426</td>
<td></td>
</tr>
<tr>
<td>Capital and Equipment</td>
<td>171,700</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Subtotal</strong></td>
<td>2,620,210</td>
<td>2,326,085</td>
<td>122,426</td>
<td></td>
</tr>
<tr>
<td><strong>Public Functions</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Food Control Costs</td>
<td>285,000</td>
<td>142,500</td>
<td>142,500</td>
<td></td>
</tr>
<tr>
<td>Nutrition Monitoring</td>
<td>410,000</td>
<td>205,000</td>
<td>205,000</td>
<td></td>
</tr>
<tr>
<td>Social Marketing</td>
<td>500,000</td>
<td>200,000</td>
<td>200,000</td>
<td></td>
</tr>
<tr>
<td><strong>Subtotal</strong></td>
<td>1,195,000</td>
<td>547,500</td>
<td>100,000</td>
<td>547,500</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>3,815,210</td>
<td>547,500</td>
<td>2,426,085</td>
<td>669,926</td>
</tr>
<tr>
<td>% of Total Budget</td>
<td>14%</td>
<td>64%</td>
<td>18%</td>
<td></td>
</tr>
</tbody>
</table>

* Includes all land, building renovation, extrusion, and packaging equipment.

** Includes all labor, packaging, overhead, 7% tax, and fortificant. Does not include raw materials (soy, sugar, rice etc.).
Annex A
Biodata for Key Contributors

This section lists the many individuals who contributed to the development of the Country Investment Plans. Listed first are individuals who served on the research and planning teams to develop each country’s CIP, and/or who attended international capacity-building workshops as country delegates. Team leaders and principal investigators are noted for each country. Next is listed the principals from the Asian Development Bank, the sponsoring and convening institution. Finally, under The Keystone Center heading are listed the consultants who led the design and implementation of the workshops and consulted with the Country Teams on the technical, economic, and other aspects of program planning and CIP development.

**Indonesia**

**DR. DIPO ALAM**  
(Team Leader)  
Deputy, Coordinating Ministry of Economic Affairs  
Chairman of National Food Fortification Commission  
Jakarta Pusat, Indonesia  
Phone No. 62 21 3521978  
Fax No. 62 21 3521971/3156541  
e-mail: dipoalam@cbn.net.id

**MR. THOMAS DARMAWAN**  
Executive Director  
Food and Beverage Association  
Jakarta, Indonesia

**MR. TATANG FALAH**  
Head  
Sub-Directorate of Food Consumption  
Directorate of Community Nutrition  
Ministry of Health  
Jakarta, Indonesia

**MR. ZAENAL ARIFIN**  
Director General  
Directorate General of Chemical, Agro, and Forest-Based Industry  
Department of Industry and Trade  
Jakarta, Indonesia

**ARIFIEN HABIBIE**  
Staff of the Deputy Coordinating Ministry of Economic Affairs  
Jakarta, Indonesia  
Phone No. 62 21 3521861  
Fax No. 62 21 3521855  
e-mail: arifenh@hotmail.com

**DR. HANS HENRY HASTOWO**  
MA, Deputy Director of External Funds  
Directorate General of Budget  
Ministry of Finance  
Jakarta, Indonesia
DR. DINI LATIEF
Director
Directorate of Community Nutrition
Ministry of Health
Jakarta Selatan, Indonesia

SUROSO NATAKUSUMA
National Food Fortification Commission
Jakarta, Indonesia

MR. HERMANI NOOR
Deputy Director of External Funds
Directorate General of Budget
Ministry of Finance
Jakarta, Indonesia

MR. H.M. YAMIN RACHMAN
Directorate
Agro Industry
Ministry of Trade and Industry
Jakarta, Indonesia

MR. ERYZAL RIVAI
PT Indo Farma
Jakarta, Indonesia

DR. H. MOCH. MA’ ROEF
Director
Food Inspection and Certification
Food and Drug Administration
Jakarta, Indonesia

MR. ANDY SETIADI
PT Gizindo Prima Nusantara
Jakarta, Indonesia

MR. ENDANG S. SUNARYO
PT Gizindo Prima Nusantara
Jakarta, Indonesia

DR. BERNADUS SUWARTO
President Director
PT Ogan Komelir Hilir
PT Parkepunan Mitra Ogan Palembang
Jakarta, Indonesia

DR. RACHMI UNTORO
Director of Community Nutrition
Ministry of Health
Jakarta Selatan, Indonesia

MR. BUDIANTO WIJAYA
Marketing Manager
PT Indofood Sukses Makmur
Bogasari Flour Mills
Jakarta, Indonesia

Pakistan

MR. MOHAMMED AYUB
(Principal Investigator)
Director, Pakistan Institute of Development Economics
Islamabad, Pakistan
Phone No. 9251 9217879/9266108
Fax No. 9251 9206407
e-mail: ar kemal@yahoo.com
pide@isb.paknet.com.pk

DR. ABDUL R. KEMAL
(Principal Investigator)
Director, Pakistan Institute of Development Economics
Islamabad, Pakistan
Phone No. 9251 9217879/9266108
Fax No. 9251 9206407
e-mail: ar kemal@yahoo.com
pide@isb.paknet.com.pk

DR. FAQIR ANJUM
Professor and Chairman
Department of Food Technology
University of Agriculture
Faisalabad, Pakistan

MR. MOHAMMED BASHIR
Senior Joint Secretary
Economic Affairs Division
Ministry of Finance
Islamabad, Pakistan

DR. ZAHID LARIK
Deputy Director General
Ministry of Health
Islamabad, Pakistan
MR. TARIQ SADIQ NILL
Chairman
Pakistan Flour Mills Association
Lahore, Pakistan

MR. TARIQ ULLAH SUFI
Director
Sufi Cooking Industry
Islamabad, Pakistan

People's Republic of China

PROFESSOR YU XIAODONG
(Team Leader)
Director
Center for Public Nutrition and Development of China
Beijing, People’s Republic of China
Phone No. 8610 63908082/8083
Fax No. 8610 63908486
e-mail: yxd@a-1.net.cn

MR. SUN XUEGONG, PH.D.
(Principal Investigator)
Economic officer
Chinese Mission to the European Communities
Avenue de Tervuren 443-445
1150 Woluwe St. Pierre, Bruxelles, Belgium
Phone No. 322 7794554
e-mail: xuegongsun@amr.gov.cn

MS. CHANG SUYING
Associate Professor
Chinese Academy of Preventive Medicine

PROFESSOR CHEN CHUNMING
Chinese Academy of Preventive Medicine
Beijing, PRC
Phone No. 8610 63170892
Fax No. 8610 83159164
e-mail: chencm@public.bta.net.cn

PROFESSOR CHEN JUNSHI
Professor
Institute of Nutrition and Food Hygiene
Beijing, PRC

MS. CHENG YING
Project Officer

Center for Public Nutrition and Development of China
Beijing, PRC

MR. DI YOUCHING
General Manager
Beijing Gu Chuan Flour Group
Beijing, PRC

MR. HE YISHAN
Deputy Director
Marketing Department
Fulingmeng Oil Company

DR. HUO JUNSHENG, M.D.
Chinese Academy of Preventive Medicine
Beijing, PRC

MR. LIANG ZIQIAN
International Department
Ministry of Finance
Beijing, PRC

MR. QUI CIJUN
Deputy Manager
Beijing Gu Chuan Flour Group
Beijing, PRC

MS. SUN JING
Associate Professor
Chinese Academy of Preventive Medicine
Beijing, PRC

MR. TANG MAO
Official
State Grain Administration
Beijing, PRC

MS. YAN JUN
Assistant Consultant
Division of NCD Control
Department of Disease Control
Ministry of Health
Beijing, PRC

MR. WANG YANHUI
Director
China Cereal and Oil Institute
PROFESSOR ZHOU HAICHUN
Deputy Director
Center for Public Nutrition and Development of China
Beijing, PRC

MS. MALEE JIRAWONGSY
Food Specialist
Food Control Division
Food and Drug Administration
Ministry of Public Health
Nonthaburi, Thailand

THAILAND

DR. SANGSOM SINAWAT
(Team Leader)
Director
Nutrition Division
Ministry of Health
Nonthaburi, Thailand
Phone No. 662 5904328
Fax No. 5904339/5918162
e-mail: nutritio@health.moph.go.th

DR. VISITH CHAVASIT
(Principal Investigator)
Associate Professor and Deputy Director
Institute of Nutrition
Mahidol University
Salaya, Thailand
Phone No. 662 8002380 ext.416
Fax No. 662 4419344
e-mail: nuvca@mahidol.ac.th

DR. CHANIN CHAROENPONG
Expert in Food Standard
Thai Food and Drug Administration
Ministry of Public Health
Nonthaburi, Thailand

MR. SANGA DAMAPONG
President
Nutrition Association of Thailand
Nutrition Division
Department of Health
Ministry of Public Health
Nonthaburi, Thailand

MS. MALEE JIRAWONGSY
Food Specialist
Food Control Division
Food and Drug Administration
Ministry of Public Health
Nonthaburi, Thailand

MS. SITIMA JITTINANDAN
Lecturer
Food Science and Technology Division
Institute of Nutrition
Mahidol University
Salaya, Thailand

MR. PISUTH LERTVILAI
Regional Marketing Manager
Human Nutrition and Health Department
Bangkok, Thailand

MS. PUANGTHIP MONARUMIT
Nutrition Division
Ministry of Health
Nontharubi, Thailand

MR. SOMMART PRAPERTCHOB
Vice Chairman
Food Processing Industry Club
The Federation of Thai Industry
Nestle (Thailand)
Bangkok, Thailand

MS. SUJIT SALEEPAN
Nutrition Division
Department of Health
Ministry of Public Health
Nonthaburi, Thailand

MR. KOSOL SAROJVISUT
Marketing Manager
Wheat Flour Miller (UFM)
Bangkok, Thailand

DR. EMORN WASANTWISUT
Professor and Director for Research and Academic Affairs
Institute of Nutrition
Mahidol University
Salaya, Thailand
Phone No. 662 4419740/8002380 ext305
Fax No. 662 4419344
e-mail: numdk@mahidol.ac.th

MR. KAWIN YONGSAWASDIKUL
General Manager
Rayong Fish Sauce Industry Co., Ltd.
Bangkok, Thailand

Viet Nam

DR. NGUYEN CONG KHAN
(Team Leader)
Director
National Institute of Nutrition
Ministry of Health
Hanoi, Viet Nam
Phone No. 844 9716058
Fax No. 844 9717885
e-mail: nckhan@hn.vnn.vn

DR. NGUYEN XUAN NINH
(Principal Investigator)
Head of Micronutrient Research Unit
National Institute of Nutrition
Hanoi, Viet Nam
Phone No. 844 9713784/9719280
Fax No. 844 9717885
e-mail: nindn@hn.vnn.vn

DR. CHU QUOC LAP
Vice Director of Food Administration
Ministry of Health
Hanoi, Viet Nam

MS. DAO THI MAI PHUONG
Engineer
Hanoi, Viet Nam

MS. DO THI PHUANG HA
Secretary of Food Fortification Program
National Institute of Nutrition
Hanoi, Viet Nam
Phone No. 844 9713784/9719280
Fax No. 844 9717885
e-mail: nindn@hn.vnn.vn

MR. NGUYEN VAN DUNG
Head of Food Registration Unit
Food Administration
Ministry of Health
Hanoi, Viet Nam

DR. NGUYEN QUANG THAO
Officer of Department Technology and Product Quality Management
Ministry of Industry
Hanoi, Viet Nam

DR. NGUYEN DINH THUONG
Vice Director
Planning Department
Ministry of Health
Hanoi, Viet Nam

MR. PHAN MANH HUNG
Deputy Director
Foreign Department
State Bank of Viet Nam
Hanoi, Viet Nam

DR. PHAN THI KIM
Director of Food Administration Department
Ministry of Health
Hanoi, Viet Nam

MR. TO HUNG THANH
Vice Director
Food Technology Department
Bienhoa Sugar Company
Hanoi, Viet Nam

MS. TRAN THI TAM
Vice Director
Food Technology Department
Haiha Confectionery Company
Hanoi, Viet Nam

MR. VU VAN CAO
Vice Director of Cathai Fishery Processing Service Company
Hanoi, Viet Nam
Asian Development Bank

DR. JOSEPH M. HUNT  
Senior Health and Nutrition Specialist (retired)  
59 Edwin Street  
Dorchester, Massachusetts 02124 USA  
Phone No. 1(617) 822-9474  
e-mail: josephhunt4@hotmail.com

The Keystone Center

MR. THOMAS GRUMBLY  
(Co-Team Leader)  
Private Investment Specialist  
President, The Keystone Center  
Keystone, Colorado, USA  
Phone No. 202 4521590  
Fax No. 202 4521138  
e-mail: tgrumbly@keystone.org

MR. JACK BAGRIANSKY  
(Co-Team Leader)  
Communication Specialist  
Atlanta, Georgia, USA  
Phone No. 404 3151845/3156466  
Fax No. 404 3151845  
e-mail: bagriansky@comcast.net  
bagriansky@mindspring.com

MR. VARGHESE ABRAHAM  
Cooking Oil Specialist  
Vice President  
Caravelle Foods  
Toronto, Canada

DR. BIENVENIDO ALANO  
Public Sector Investment Specialist  
President  
Center for Economic Policy Research  
Quezon City, Philippines  
Phone No. 632 4152156  
Fax No. 632 7212032  
e-mail: cepr@mozcom.com

DR. PETER ADLER  
Director, Science and Public Policy  
The Keystone Center  
Keystone, Colorado, USA

DR. JACK FIEDLER  
Health Economist  
Social Sectors Development Strategies  
Sturgeon Bay, Wisconsin, USA

MR. QUENTIN JOHNSON  
Flour Technology Specialist  
President  
Quican, Inc.  
Toronto, Canada

MR. GEORGE PURVIS  
Complementary Foods Specialist  
Palm Desert, California, USA

MR. BRAD SPERBER  
Senior Associate  
The Keystone Center  
Washington, DC, USA  
Phone No. 202 4521590  
ext.16/1301 6491865  
Fax No. 202 4521138  
e-mail: bsperber@keystone.org

DR. KEVIN SULLIVAN  
Nutrition Monitoring and Surveillance Specialist  
Associate Professor  
Department of Epidemiology  
Emory University  
Atlanta, Georgia, USA

JENNIFER THOMAS-LARMER  
Editor  
Larmer Consulting  
Watertown, Massachusetts, USA

DR. HERBERT WEINSTEIN  
Quality Assurance and Food Control Specialist  
Arlington, Virginia, USA
The following consensus statements were developed at the regional workshops discussed in Chapter 1.

**Consensus Statement on Cooking Oil Fortification**
Regional Workshop on Flour and Cooking Oil Fortification
6–8 November 2001
Asian Development Bank
Manila, Philippines

After 3 days of deliberation, participants from five Asian nations, attending a workshop on wheat flour and cooking oil fortification on 6–8 November 2001, sponsored by the Asian Development Bank, agreed on the following set of principles, strategies, and actions.

1. **We recognize:**
   - that Vitamin A Deficiency (VAD) is a widespread problem with well-documented human and economic impacts;
   - that improved Vitamin A status worldwide would be expected to prevent approximately 1.3–2.5 million deaths among children under 5 years of age (WHO 1993);
   - that improvement of Vitamin A status in the young child population leads to a reduction of 23% in all-cause child mortality (UNICEF 1993);
   - that improved Vitamin A status can reduce mortality during pregnancy;
   - that prevalence of VAD in this region is generally considerably higher than the WHO cut-off point, ranging from 20% to 50% among countries participating in this initiative.

2. **We affirm:**
   - that the addition of Vitamin A to all cooking oil sold for human consumption is a well-established method for eliminating VAD as a societal problem;
   - that fortification of cooking oil with Vitamin A is an inexpensive and effective intervention to reduce VAD;
   - that fortification of cooking oil with Vitamin A is feasible technically, economically, and politically;
   - that successful models of fortification of cooking oil products with Vitamin A already exist and are operating in the Asian market;
   - that people of the region should have access to affordable, safe, and efficacious fortified foods as a permanent commitment to the elimination of micronutrient malnutrition;

---

58 Indonesia, Pakistan, the PRC, Thailand, and Viet Nam. An unofficial delegation from India was also present. The Government of India reserved its opinion regarding the consensus statement.

59 The important contribution of other oil-based products (e.g., shortening, margarine) was fully recognized by the group as carriers for Vitamin A. However, it was felt by participants that these other products might not be as well targeted to at-risk populations.
that the consequences of not implementing fortification programs at the national level will be high mortality and morbidity rates for children and mothers, poor child development, low educational achievement of children, and decreased earnings and economic growth;

that significant benefits can also be achieved by simultaneously addressing micronutrient malnutrition through regional alliances, networks, and institutions.

3. **We recommend:**

   *We therefore recommend the following national and regional actions to achieve reduction of VAD in the region.*

**NATIONAL ACTIONS**

- Pass mandatory oil fortification laws or regulations in all participating countries in the region by 2006. Implementation schedules will be developed on a country-by-country basis depending upon the size and complexity of the fortification projects. The minimum level of fortification should be 25 IU per gram, with precise levels to be determined by the individual countries. Alternatively, the minimum level of fortification should deliver 25% of RDA of Vitamin A per average daily consumption, after accounting for all losses.

- Develop and effectively implement programs for universal oil fortification within all countries in the region.

- All countries in the region should take measures to ensure consumer acceptance by embarking upon consumer education campaigns regarding the health benefits, safety, and quality of fortified oil.

- All countries in the region should ensure adequate regulatory control and enforcement of fortification laws to ensure successful implementation.

- Each country government should facilitate a robust public-private partnership to ensure the sustainability of fortification programs and to provide ample controls to safeguard the safety and health of the consuming public.

- In order to assist with the development of consumer confidence in and national consensus around fortified oils, research should be conducted into stability, efficacy, and packaging options according to each country’s production and consumption circumstances. Existing scientific literature can serve as useful reference.

- Countries should urge the elimination of nontariff trade barriers to food fortification, to promote timely implementation and sustainability.

**REGIONAL ACTIONS**

- Establish a Regional Center of Excellence in Food Fortification, to undertake the following activities regarding cooking oil fortification:
  - Development of regional and international trade standards and guidelines for fortified foods
  - Development of quality assurance procedures
  - Provision of relevant training and capacity building
  - Research into stability, efficacy, and new packaging materials in order improve continuously upon the quality and effectiveness of end products
  - Take measures to reduce the price of the fortificant, including investments in producing the fortificant in the region.
  - Secure strategic investment in private/public quality assurance capability in the region, including investment in adequate training and testing facilities.
  - Participating countries hope that ADB will continue to play a constructive leadership role in supporting fortification efforts in the region.

4. **Signatories:**

   The participating delegations from Viet Nam, Thailand, People’s Republic of China, Pakistan, and Indonesia endorsed this statement by consensus during the workshop. Delegations represented a broad partnership of public- and private-sector representatives.
Regional Workshop on Flour and Cooking Oil Fortification
6–8 November 2001
Asian Development Bank
Manila, Philippines

After 3 days of deliberation, participants from five Asian nations attending a workshop on wheat flour and cooking oil fortification on 6-8 November 2001, sponsored by the Asian Development Bank, agreed on the following set of principles, strategies, and actions.

1. **We recognize:**
   - that iron deficiency is causing serious damage to social and economic development through poorer pregnancy outcomes, impaired cognition especially in young children, reduced work capacity, and increased morbidity from infectious diseases;
   - that zinc deficiency is associated with lowered immunity, slower growth, and increased risk of heavy metal poisoning in contaminated environments;
   - that folic acid deficiency in women who become pregnant contributes to congenital abnormalities of the central nervous system of the newborn and is an independent risk factor for coronary heart disease, and contributes to anemia;
   - that the key B-vitamins thiamin, riboflavin, and niacin along with most iron and folic acid are removed during milling, contributing to micronutrient malnutrition among populations whose diets include noodles, bread, and other flour-based foods;
   - that while additional research and development is needed in specific areas to define optimal iron fortification approaches, it is also recognized that *nutrition delayed is equivalent to nutrition denied*, and therefore countries of the region should move forward consistent with the current evidence and scientific consensus.

2. **We affirm:**
   - that the addition of micronutrients to flour according to the guidelines elaborated below is a feasible, affordable, and efficacious method to reduce the prevalence of these key micronutrient deficiencies;
   - that white flour of ash content up to 0.80% should include a basic package of micronutrients according to the following guidelines as an initial reference point:
     1. 60 ppm iron as electrolytic iron or 30 ppm iron as ferrous sulfate
     2. 30 ppm zinc
     3. 2.5 ppm thiamine
     4. 4 ppm riboflavin
     5. 2 ppm folic acid
   - that *atta* flours (unrefined brown flours) or flours with ash content of more than 0.80% include a basic package of micronutrients according to the following guidelines:
     1. 60 ppm electrolytic iron
     2. 30 ppm zinc
     3. 2 ppm folic acid
   - that when considered feasible and affordable, standards for electrolytic iron in *atta* flours substitute equivalent levels of sodium iron-EDTA or disodium EDTA plus ferrous sulfate;
   - that where these deficiencies are of high public health concern, the basic package above be enhanced with the addition of Vitamin A, Niacin, B6, B12, and/or calcium at levels delivering 25% of RDA at average levels of daily consumption;

---

60 Indonesia, Pakistan, PRC, Thailand, and Viet Nam. An unofficial delegation from India was also present. The Government of India reserved its opinion regarding this consensus statement.

---

61 Electrolytic iron appears to be the best choice of the elemental iron powders at the current state of our knowledge. If electrolytic iron is not available at a reasonable cost, another type of elemental iron powder may need to be considered. Whatever type of elemental iron powder is selected, it is recommended that 325 mesh (<45 microns) be used rather than 100 mesh as specified for reduced iron in the current FCC guidelines.
that there are no capacity constraints for private roller millers to implement the guidelines above and to provide affordable fortified flour to their consumers; and that the consequences of not implementing fortification programs at the national level will be poor child development, low educational achievement of children, and decreased earnings and economic growth.

3. **We therefore pledge**

- that governments and producers work together towards a goal of fortifying all flour used in the preparation of staple foods such as leavened and unleavened breads, noodles, pastas, biscuits, and other flour products that are consumed by populations at risk of micronutrient deficiencies by the year 2006.

4. **We recognize that the achievement of these critical goals will require:**

- that countries of the region establish an enabling environment for fortification of flour by working towards national mandatory standards for all flour used in the preparation of staple foods such as breads, noodles, pastas, biscuits, and other flour products that are consumed by populations at-risk of micronutrient deficiencies;
- that food laws and regulations be reviewed and amended to ensure they support and enable the addition of all essential micronutrients in appropriate food carriers;
- that public policies and regulations constraining or impeding investment in food fortification be reviewed and amended and that all nations collaborate to produce uniform or consistent standards based on international best practices;
- that customs protocols and trade regulations be revised or enacted to facilitate the import and export of certified and safe fortified foods;
- that the cost of food fortification must ultimately be borne by the producer and the consumer, but a transition period of cost sharing between the public and private sectors may be necessary;
- that efforts be continued to inform the public of the benefits of fortified flour to the learning and earning capacities of the region's children;
- that food fortification must be a part of a comprehensive strategy of anemia prevention and control that includes supplementation, dietary diversification, breast feeding promotion, and other public health measures.

**NATIONAL ACTIONS**

5. **We further recognize that the achievement of flour fortification will require the following coordinated actions at national, provincial, and local levels:**

- Pass and effectively implement mandatory laws for flour fortification in a timely fashion, that these laws reflect consideration of the guidelines for the minimum basic package and enhanced package of micronutrients elaborated above.
- Enhance current regulatory frameworks and build capacity to implement food control and enforcement functions in a systematic, transparent, and fair manner.
- Establish a monitoring framework to assess the effectiveness of flour fortification on the population with particular emphasis on populations defined as at-risk of micronutrient deficiencies.
- Urge the elimination of all tariffs, sales taxes, value-added taxes, and other fees or charges on the inputs to fortification and fortified food products.
- Systematically review all tariffs, sales taxes, value-added taxes, and other fees or government charges that impact the price of fortified flour products to identify appropriate mechanisms for government cost sharing until such time as the costs of fortification can be fully passed on to the consumer.
- Systematically review all government sources of revenue derived from the import and sale of wheat, flour, and flour products to identify appropriate mechanisms to ensure full support to government regulatory and enforcement functions, nutrition surveillance and monitoring functions, and public education and social marketing of fortified flour.
• Collaboration among public and private sectors to ensure that any consumer price rise in fortified products is reasonable and fairly reflects only the incremental costs of flour fortification.

• Collaboration among government, industry, and international donors to define sustainable mechanisms passing all costs of fortification, quality assurance, enforcement, and marketing to the consumer as soon as feasible.

• Integrate fortification into national programs and policies, including a requirement that all public purchases of flour and flour products be fortified.

• In countries where the small milling sector represents a significant proportion of flour production, move forward on an accelerated basis to address technical and commercial constraints at the small mill (chakki).

• Promote an expanded public/private sector dialogue on the fortification of wheat flour and organize advocacy events to increase program and donor support.

• Develop and implement a communication strategy to raise public awareness of the benefits of fortified wheat flour and wheat flour products and promote increased consumer preference for these products.

REGIONAL ACTIONS

6. We further recognize that the achievement of flour fortification will require the following coordinated actions at the regional level:

• Develop a framework for drafting and proposing harmonized regional and international trade standards and guidelines for fortified foods.

• Develop regional activities such as roundtables, joint reports, and crosscountry training focusing on legislation, communication strategies, and capacity building for public and private sectors including the establishment of a regional millers’ association.

• Open a dialogue with regional and global suppliers of premix, microfeeders, and other fortification-related technology to explore partnerships for cost-effective regional production and distribution of these critical inputs.

• Demonstrate through regional policy dialogue to economic planning agencies and the general public the large economic damage caused by poor nutrition and the proven low-cost solutions available to the region.

• Advocate resource mobilization by governments from domestic budgets, public and private sectors, and strategic investments from development partners, and share country experience in regional forums.

• Review and recommend financial and capacity-building incentives to sustain food fortification and its expansion to other essential foods widely consumed by the poor.

• Create communication mechanisms to share advocacy, technical, and promotional activities among themselves and with the global community.

• Include micronutrient malnutrition issues into the agenda of regional expert group consultations such as associations of pediatricians, nutritionists, and reproductive health specialists.

• Prepare progress reports toward elimination of micronutrient malnutrition to the appropriate councils of regional organizations such as ASEAN, SAARC, as well as APEC.

• Develop expert committees and other mechanisms to finance, undertake, peer review, and develop regional consensus of research and development in areas including:

1. Fortification and quality assurance at small mills

2. Comparative bioavailability of iron compounds in all flours with particular attention to atta flours

3. Interaction of micronutrients and their impact on both organoleptic characteristics and bioavailability

4. Loss of vitamins during cooking and processing

5. Accelerate review, replication, and expansion of NIN/Hyderabad's current research into the bioavailability of iron in atta flours

6. Review national and regional regulatory and trade protocols with a view to smoothing out the import and export of fortified food products
7. **Signatories:**

The participating delegations from Viet Nam, Thailand, People’s Republic of China, Pakistan, and Indonesia endorsed this statement by consensus during the workshop. Delegations represented a broad partnership of public and private sector representatives.

---

**Consensus Statement on Regulation, Quality Assurance, Surveillance, and Trade of Fortified Processed Foods**

Regional Workshop on Regulation, Quality Assurance, Surveillance, and Trade of Fortified Food Products

23–25 April 2002
Bangkok, Thailand

*After 3 days of deliberation at the Regional Workshop on Regulation, Quality Assurance, Surveillance, and Trade,**62 delegations representing the public and private sectors from Indonesia, Pakistan, People’s Republic of China, Thailand, and Viet Nam,63 along with other esteemed participants, agree on the following set of principles, strategies, and actions.*

1. **We recognize that:**

   - Micronutrient deficiencies are causing serious damage to social and economic development through poorer pregnancy outcomes, impaired cognition especially in young children, reduced work capacity, and increased morbidity and mortality from infectious diseases;
   - Improved nutrition is one of the key components to the reduction of poverty and the raising of human resource quality contributing to sustained economic and social development;
   - Efforts to improve nutrition are the joint responsibility of the public and private sectors;
   - *Privatization of poverty reduction* involves the partnership of the public, private, and civic sectors, and the processed food industry’s contribution of fortified, affordable, and essential foods widely consumed by the poor is an example of such a partnership;
   - Food fortification offers a significant low-cost and sustainable approach to reducing the prevalence of these deficiencies;
   - The contribution of food fortification to the Millennium Development Goals arises from public-private partnerships, especially the reduction of hunger and absolute poverty and the mortality of women and young children, while supporting the readiness of children to learn to their full potential;
   - While additional research and development is needed in specific areas to better define optimal fortification approaches, it is also recognized that *nutrition delayed is equivalent to nutrition denied,* and therefore countries of the region should move forward consistent with the current evidence and scientific consensus.

2. **We affirm that:**

   - It should be the public policy to make available to our populations foods fortified with Vitamin A, iron, iodine, folic acid, and other critical micronutrients at levels sufficient to impact public health.64

---


63 The delegation from India believes that appropriate ministries of Government must review this statement to have the opportunity to assess its content, and suggest changes and amendments. Therefore, the Indian delegation reserved the right to become a signatory to this statement at a later date.

64 Vitamin A, iron, iodine, and folic acid are viewed as especially important at this time because of the magnitude and widespread nature of their deficiencies, the evidence of significant public health and socioeconomic problems that the deficiencies are causing, and the availability of cost-effective interventions.
Each delegation's country currently has, or will at the appropriate time propose, the legal authority needed for adequate regulation of a fortified food supply.

Collaboration between government, private sector, and civil society is the key to sustained and effective implementation of food fortification to reduce micronutrient deficiencies.

Investment in food fortification offers a significant opportunity over the medium to long term for poverty alleviation and the acceleration of national social and economic development.

Substantial additional investments will be necessary to implement quality food fortification initiatives throughout the region, and these investments are justified due to the high human, social, and economic returns, such as:

1. Substantially increased GDP for all countries in the region;\(^\text{65}\)
2. Increased economic competitiveness due to improved nutritional status;
3. Substantial reduction in several chronic and subchronic disease states;
4. Substantial additional effects in improving the overall food inspection systems and;
5. Promoting Asian competitiveness and penetration of the global markets in food trade.

While the precise range of vehicles selected for fortification will vary from country to country, the delegations propose that their countries fortify flour with iron and folic acid, cooking oil with vitamin A, salt with iodine, and that further research on the bioavailability in brown or atta flours and the fortification of sugar with Vitamin A be researched.

Investments and reforms to expand existing food control and quality assurance systems will enable production and trade in fortified food products, on a domestic and international basis, fairly and transparently throughout the region.

To achieve the above, the following national actions are necessary:

1. **Legal and Regulatory Framework**—The Governments of the nations whose delegations were party to this Consensus Statement should:

   - Establish appropriate intergovernmental and/or institutional mechanisms to implement effective policy in concert with partners in industry and civil society.
   - Communicate clearly the benefits of fortification to the public, make appropriate legal requirements and standards to be observed by the food industry, and ensure consistency and coordination among government agencies.
   - Establish mechanisms enabling the private sector and civil society to bring the full extent of their resources, expertise, and credibility to bear on the promotion of fortified food products.

   In the case of mandatory fortification programs, minimize taxes and duties on inputs to fortification as well as taxes on domestically produced fortified food products.\(^\text{66}\) Participating countries agree to refer to the appropriate ministries the proposed suspension of all tariffs on fortificants and fortification technologies. The impact of these actions will be reviewed by an independent expert panel that will allow the region to assess (1) the revenues foregone versus profitability of the private sector, and (2) the social benefits to consumers, especially the poor.\(^\text{67}\)

2. **Food Control and Quality Assurance Framework**—Appropriate governmental authorities from the nations whose delegations were party to this Consensus Statement should:

   - Ensure adequate legal power to enforce fortification laws, with respect to the inspection of plants, records, and products.

---

\(^{65}\) Additionally, some delegations also believe that increased emphasis on nutritional development will have substantial direct positive effects on the development of industry in the region, thereby shifting public resources for other societal problems.

\(^{66}\) Delegations noted that consultations with national parliaments and in some cases international organizations may precede confirmation of the noted recommendation.

\(^{67}\) The Indian delegates respectfully believe that this issue may not be considered for India due to revenue loss to the Government.
• Initiate programs to empower inspectors and technicians. This should include a range of incentives as well as penalties to enable personnel to enforce laws fairly and transparently. A combination of improved recruitment, training, protocol development, oversight, and increased penalties should be implemented, with a view toward zero tolerance of corruption in the inspection force and in industry.

• Empower consumer protection organizations to identify abuses and bring them to light in the public media, the judicial process, and the government.

• While current sampling, analytical, and laboratory capacities are limited, work to define the human and financial resources necessary for effective functioning and enforcement of quality assurance systems.

• Work toward a flexible system of sampling and enforcement that provides incentives to the private sector for consistently performing to quality standards.

3. Nutrition Surveillance Framework—The appropriate public health authorities in the nations whose delegations were party to this Consensus Statement should work to:

• Implement nutrition surveillance systems for four key micronutrients: iron, Vitamin A, iodine, and folic acid.

• Produce reliable and regionally equivalent data on population micronutrient status through the use of the following harmonized approaches:
  - Common protocols and methods of surveillance at a regional level;
  - Standardized representative cross-sectional surveys of sufficient sample size;
  - Targeting surveys to parallel population groups as follows:
    - iron—women of child-bearing age and adolescent girls;
    - Vitamin A—preschool children and possibly pregnant and lactating women;
    - iodine—6- to 12-year-old children and/or women of child-bearing age
    - folic acid—women of child-bearing age
  - Use of common biochemical indicators as follows:
    - iron—hemoglobin with the addition of other indicators;
    - Vitamin A—serum retinol;
    - folic acid—serum or RBC folate;
    - and iodine—urinary iodine.

• Endeavor to use intermediate surveys to assess the household and intrahousehold use of fortified foods and to periodically reassess individual biological indicators when coverage meets accepted goals, particularly people in target at-risk groups.

• Mobilize additional financial and human resources for the upgrading of national laboratories as well as training for lab technicians and field workers.

4. To achieve the above, the five countries signatory to this Consensus Statement recognize that networks building regional collaboration and capacity will provide an Asian framework for effectively working together to:

1. Establish a Legal and Regulatory Framework:

• Create mechanisms, under the auspices of existing institutions (e.g., WHO, ASEAN, SAARC, APEC), to harmonize standards and ensure no unnecessary barriers to trade.

2. Establish a Regional Food Control and Quality Assurance Framework:

• Through collaboration of regional institutions such as ASEAN and SAARC with international accreditation bodies such as ISO or NABL, establish accreditation of quality-control laboratories in government, industry, and academe. Through this process a harmonized regional laboratory network for fortified foods should be in place by 2005.

• A Regional Center of Excellence and Expertise—new or existing—should initiate a training-of-trainers program for inspectors, analysts, and technicians. This trained corps will be sufficiently empowered and resourced to conduct sequential in-country trainings of their respective national government, industry, and academic institutions.
• For the purposes of fair and transparent regional trade as well as domestic food control, when the above-described laboratory accreditation and human resource development process is established, certification from an accredited laboratory will validate product and/or micronutrient quality to the appropriate inspectors.

3. **Nutrition Surveillance Framework:**
   • Mobilize investments that will lead to: a common surveillance framework and common guidelines; adequately staffed regional reference laboratory and individual country laboratories; and the bulk purchasing of lab kits.

4. **National and Regional Investment Planning and Resource Mobilization:**
   • The signatories to this consensus statement appreciate the importance of reaching regional consensus on appropriate food fortification technologies, the applications of science to measure food composition, and the assurance of food safety and domestic nutrition improvements. Of equal importance, the signatories recognize that Country Investment Plans prepared under the project will require careful review of existing policies and programs for surveillance, quality assurance, and regulatory, customs and trade protocols. Both structural reforms and resource mobilization are the next steps for each country and for the region. The signatories request assistance of the Asian Development Bank, The Keystone Center, and other Development Partners to raise the level of resource commitments for Asia.

**Signatories**
Delegations representing the public and private sectors of Pakistan, Viet Nam, People's Republic of China, Indonesia, and Thailand.

---

**Consensus Statement on the Fortification of Complementary Foods**
Regional Workshop on Optimizing Child Growth and Development Through Improving Complementary Feeding Including Use of Fortified Processed Complementary Foods
25–27 June 2002
Singapore

After 3 days of deliberation at the regional workshop, delegations representing the public and private sectors from Indonesia, India, Pakistan, People's Republic of China, Thailand, and Viet Nam, along with other esteemed participants, agree on the following set of principles, strategies, and actions.

1. **We recognize that:**
   • The numbers of underweight, stunted, and micronutrient-deficient children in Asia are the highest in the world, and the consequences of this condition are avoidable, premature death; mental and physical disabilities that lead to high school dropouts, low employability, low wages, and low household investment in the quality of the next generation’s children; and lost economic growth that will jeopardize the region’s ability to compete in the global marketplace.
   • Early Child Nutrition is an essential part of Human Resources Development Policy in all Asian countries.
   • The optimal period of physical and mental development is in pregnancy and the first 2 years, and the maximum prevalence of malnutrition mainly occurs from 6 to 24 months. This is a largely unexplored “window of opportunity” for society to influence the hopeful prospects of Asia’s newborns for lifelong learning and earning.
   • The Millennium Development Goals, to which all Asian nations and their Development
Partners subscribe, set the world’s agenda through 2015: virtual elimination of maternal, infant and young child mortality; universal primary school enrollment and completion; and halving of hunger and poverty in the developing world.

- The role of government is critical in setting policies, programs, and standards that involve all stakeholders through participation and accountability, and in utilizing public funds for the lowest cost to government and highest benefit to optimal child growth and development.
- The guiding principles to optimizing child growth and development according to the WHO include: ensuring adequate supplementation for pregnant and lactating women as long as they are lactating, universalizing exclusive breastfeeding for the first 6 months of life, followed by introduction of complementary foods of both locally produced/home-prepared and industrially processed types, reinforced by good infant feeding practices and good domestic hygiene.
- Processed Complementary Foods (CFs) represent an important niche in the family's options to meet the extraordinarily high requirements for micronutrients in the first 2 years, and should be developed with the adequate standards of quality, safety, efficiency and cost-effectiveness so that they will be widely available and affordable to lower socioeconomic groups where the worst nutrition problems are concentrated. These foods are not a replacement for breastfeeding or home-prepared CF.
- Convergence of nutrition in public health strategies should support optimal child growth and development, and the interventions include quality health, health education, and nutrition services to mother and child, incorporation of complementary feeding into health care delivery, promotion of healthy nutrition behaviors through home visits for assessment care and referral, social marketing of CFs of every type for informed choice by parents and other primary caregivers, and compliance with the International Code for Marketing of Breast Milk Substitutes.
- Delivery of the Comprehensive Maternal and Child Health and Nutrition Package is the most cost-effective way to assure high levels of educational achievement and productive contribution to society.
- There is scope and need for building a public-private-civil society partnership to make mutually reinforcing contributions to optimizing child growth and development.
- This depends crucially on the adoption and maintenance of the accepted professional standards, i.e., avoidance of unethical practice, such as offering free samples of CFs to mothers of infants under 6 months.

2. **We affirm that:**

- CFs are an integral component of programs for optimizing nutrition for young children.
- The addition of micronutrients to CFs according to the Codex Alimentarius along with the most current guidelines such as WHO-UNICEF recommendations of 2002 is a feasible, affordable, and efficacious method to reduce the prevalence of key micronutrient deficiencies in children 6-24 months.
- Public policy should strive to enable production to make available to children 6–24 months CF-fortified critical micronutrients at levels sufficient to impact public health.
- As an initial reference point, guidelines for fortification for processed CF should include at least iodine, iron, vitamin A, and folic acid at 50–100% of RDA on the basis of daily consumption. Additional micronutrients at these levels could be considered by individual countries on a case-by-case basis.
- A collaboration of public, private, and civic sectors is critical to creating an enabling environment to expand production and distribution of affordable and appropriate fortified complementary foods. Substantial investments will be needed to provide access to affordable and appropriate fortified CF, and these investments are justified due to the high human, social, and economic returns.

---

68 The Indonesian delegation reserves its opinion regarding this clause.
3. **We therefore pledge to raise the priority of Complementary Feeding and fortified CFs as an integral component of the child nutrition package through these activities:**

   - Develop a regulatory environment that supports and promotes complementary feeding and exclusive breast feeding as equally important components of health and nutrition for children under 2 years of age.
   - Multisectoral advocacy to build support at all levels of government for investment in early child nutrition within government and political leadership including local and municipal institutions.
   - Develop national standards for appropriate and ethical marketing of micronutrient-fortified CF based on the current WHO-UNICEF Guidelines.
   - Set national goals for increased production and distribution of affordable fortified CF including both public and private sectors.
   - Review public policy and behavioral barriers to the expansion of production and marketing capacity including small- and medium-scale enterprises.
   - Develop opportunities to integrate investment in production, distribution, and promotion of fortified CF into public health and development programs with clear linkages to all key child nutrition strategies, including breastfeeding, child care, hygiene, and maternal health and nutrition.
   - Include fortified complementary foods in all public distribution and food subsidy programs.
   - Conduct technical research regarding CF fortification in five areas, several of which may generate concern in specific country situations regarding the introduction of CFs into national systems. These areas are nutritive value, safety, affordability, accessibility, and acceptability.

4. **We recognize that the following coordinated set of actions will be necessary at national, provincial, and local levels:**

   - A variety of technologies, products, and marketing strategies including complete CFs, nutrient supplements, and dietary education targeted according to risk status, local foods, and cultures.
   - Public incentives to enable the production sector to expand affordable product offerings to at-risk children through the awarding of government seals of approval, generic public promotional campaigns, and special access to government channels of distribution and communication as well as targeted subsidies.
   - Public policies regarding use of subsidies will be reviewed to ensure that adequate resources are focused on the Comprehensive Package, including pregnant and lactating women and under-twos. Where appropriate, resources should be redirected to fortify food provisions for young children and their mothers, uses of external food assistance should be directed to under-twos and their mothers, and partial use of special public funds should be reserved for innovative approaches to poverty reduction.\(^\text{59}\)
   - Public-private partnership should be extended to industrial and trade policies, with careful consideration of whether the pattern and level of tariffs and value-added taxes help or impede the delivery of processed CFs to children in need. Adjustments to those fiscal and trade policies may be required if potential revenues foregone are exceeded by long-term benefit streams to families and nations.\(^\text{70}\)
   - Governments will ensure that the code of conduct for the private sector will include marketing guidelines for CFs, including labeling and advertisement that direct the consumer to feed children older than 6 months only.
   - Industry should be encouraged to introduce multitier pricing for products directed to less-affluent market segments without compromising on product quality.
   - Capacity building to upgrade medium- and small-scale enterprises to enable production of fortified CF to simultaneously develop local business and income generation opportunities along with provision of CF.
   - Comprehensive social communications and marketing to raise consumer demand and awareness based on research to determine feeding practices, motivations, and barriers to acceptance and efficacy of fortified complementary foods.

\(^{59}\) The Indian delegation reserves its opinion regarding this statement.

\(^{70}\) The Indian delegation reserves its opinion regarding this statement.
Training of health care providers to provide essential communication to support the use of fortified CF in all contacts with pregnant women and mothers of newborns as well as all children under 24 months of age.

Based on individual country situations, research may be needed before widespread implementation of CF production and distribution systems are put in place:

(i) nutritional quality and safety—develop appropriate guidelines for small and medium enterprises to enable adherence to Good Manufacturing Principles and Codex Alimentarius, and for food safety (protection against microbiological, antinutritional, and toxic factors).

(ii) market research on affordability of the CF products for lower socioeconomic segments.

(iii) research linking assessment of micronutrient deficiencies in target populations, and analysis of ideal protein, energy, and micronutrient balance in CFs, including risk of under/over dosing.

(iv) consumer acceptability tests (sensory) based on updated methodologies research linking appropriate and hygienic introduction of locally prepared CFs and balanced use of processed CFs.

(v) accessibility of processed CFs, particularly in remote areas, related to local production using appropriate technology (with production manuals) and distribution networks.

(vi) develop the feasibility of nutrient food supplements such as “sprinkles,” “spreads,” and “foodlets” of appropriate size and portion in locally prepared CFs where processed foods are not accessible or affordable, and testing consumer preference, food preparation practice, and potential risks.

(vii) research on product/process development and technology transfer with industry’s cooperation.

(viii) behavioral research on pregnant and lactating mothers (in terms of feeding patterns and energy expenditure of infants along with the nutritional quantity and quality of breast milk and sustaining their own nutritional needs during prolonged lactation).
Annex C
Estimation of the Impact of Vitamin A Fortified Foods on the Prevalence of Vitamin A Deficiency

by Kevin Sullivan and Jack Bagriansky

Vitamin A deficiency (VAD) is a significant global health problem. A variety of intervention strategies have been devised to eliminate VAD and therefore prevent the morbidity and mortality associated with it. Interventions to prevent VAD include the use of vitamin A supplements and the fortification of commonly eaten foods. While vitamin A supplementation has played an important role in preventing VAD, the distribution of capsules to target groups (usually preschool children and women after delivery) can be difficult to maintain, particularly at high coverage levels over long periods. The fortification of commonly consumed processed foods is an alternative that has a number of advantages over supplementation. The impact of vitamin A fortified foods on VAD has been infrequently studied. In this manuscript, we estimate the impact of vitamin A fortified food on the prevalence of VAD.

A review of the literature identified three studies on the effect of vitamin A fortified foods on the prevalence of VAD, based on laboratory assessment in children. These studies used the prevalence of low serum retinol levels to define VAD. The studies are as follows.

• A study in Indonesia using fortified monosodium glutamate (MSG; 810 micrograms of retinol equivalent (RE)/gram), a controlled field trial, and serum retinol values in preschool children. In the study area, 80% of the MSG was fortified (Muhilal, et al., 1988).

• A study in Guatemala using fortified sugar (10 micrograms RE/gram), a “before and after” assessment of 10 sentinel sites, and serum retinol values in preschool children (Arroyave, et al., 1981).

• An assessment of sugar fortification in Guatemala using fortified sugar, serum retinol values in adults, and national estimates using a “before and after” design (Dary, 1999).

The results of the studies are depicted in Table C1. The foods fortified were either MSG or sugar; the estimated daily intake of vitamin A from the fortified foods varied from 117 to 345 micrograms; and the baseline prevalence of VAD varied from 26% to 48%. The estimated daily intake of vitamin A from the fortified food takes into account the level of fortification and estimates of the amount of the food consumed per day and the proportion of individuals consuming the fortified product. While the food vehicles and overall diets involved vary in these studies and assessments, for the purposes of projecting the impact of added vitamin A on the prevalence of VAD it is assumed that each microgram of actual vitamin A intake will have a consistent and comparable impact regardless of the vehicle.

These studies provide three point estimates. To enable an estimation of the impact of a fortified food on prevalence, we assumed the following.

1. If the daily intake were half as high as reported, then the ratio from the pre- to post-prevalence of VAD would be halved. For example, if an
average daily vitamin A intake were 200 micrograms and the ratio was .5 (i.e., a 50% reduction in the prevalence from baseline), then with an intake of 100 micrograms we would expect a ratio of .75. For example, if a study were performed with 200 micrograms vitamin A per day and a baseline prevalence of 50%, if the ratio were 0.5, then the post-fortification prevalence estimate would be 25% (50% * .5); assuming half that intake would be 100 micrograms per day, with a baseline prevalence of 50%, the reduction would equal \((\frac{37.5\% (100\% - 50\%) \times 2}{2} + 50\%) = .75\). Similar relationships were assumed if the daily intake were one quarter, where the impact on prevalence would be one quarter.

2. If the daily intake were doubled, then the decline in the prevalence of VAD would be doubled; if the dose were halved, the reduction would be halved.

These estimates are presented in Figure C1 and Table C2. These points were plotted and curves were plotted to determine which type of curve fit the data best. The quadratic approach appeared to fit best. (See the “curve fit” explanation at the end of this annex.) The quadratic equation is as follows.

\[
\text{Post-fortification prevalence} = \text{pre-fortification prevalence} \times (1.019752 - .003178(\text{vit A } \mu\text{g/day}) + .00000282156958(\text{vit A } \mu\text{g/day})^2)
\]

“Post-fortification prevalence” is the estimated prevalence (%) of vitamin A deficiency after fortification, “pre-fortification prevalence” is the estimated prevalence (%) of vitamin A deficiency prior to the fortification program, and “vit A \mu\text{g/day}” is the estimated daily intake from consuming a vitamin A fortified product. Use of the quadratic estimates compared with the actual reported post-fortification prevalence of vitamin A deficiency shows that the estimation procedure seems to work well. (See Table C3.)
TABLE C2. Actual daily intake of vitamin A and estimates if intake had been double, half, or one
quarter of the ratio of pre- to post-fortification prevalence of VAD

<table>
<thead>
<tr>
<th>Study</th>
<th>Double</th>
<th>Actual</th>
<th>1/2</th>
<th>1/4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Study 1</td>
<td>234.00</td>
<td>117.00</td>
<td>58.50</td>
<td>29.25</td>
</tr>
<tr>
<td>Study 2</td>
<td>690.00</td>
<td>345.00</td>
<td>172.50</td>
<td>86.25</td>
</tr>
<tr>
<td>Study 3</td>
<td>270.00</td>
<td>135.00</td>
<td>67.50</td>
<td>33.75</td>
</tr>
</tbody>
</table>

For study 1:
Going from 117 to 234 micrograms: \( .66/2 = .33 \)
Going from 117 to 58.5 micrograms: \( \frac{(1 - 0.66)}{2} + 0.66 = 0.83 \)

Table C3: Comparison of the actual vs. estimated impact of vitamin A fortified foods on the post-fortification
prevalence of vitamin A using the quadratic approach

<table>
<thead>
<tr>
<th>Food Fortified</th>
<th>Average Intake of Vitamin A from Fortified Food (µg)</th>
<th>Daily Pre-Fortification Prevalence of VAC</th>
<th>Post-Fortification Prevalence of VAC</th>
<th>Estimated Post-Fortification Prevalence of VAC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Field Trial</td>
<td>MSG 117</td>
<td>48%</td>
<td>31%</td>
<td>33.0%</td>
</tr>
<tr>
<td>Sentinel Site</td>
<td>Sugar 345</td>
<td>27%</td>
<td>9%</td>
<td>7.0%</td>
</tr>
<tr>
<td>National Estimates</td>
<td>Sugar 135</td>
<td>26%</td>
<td>16%</td>
<td>16.7%</td>
</tr>
</tbody>
</table>

Conclusions

There are relatively few studies available that describe the impact of vitamin A fortified foods on the prevalence of vitamin A deficiency. Three studies were used to make this estimation. Linearity was assumed between the daily intake of vitamin A and the ratio from pre- to post-fortification vitamin A deficiency prevalence. It is unknown whether this linear assumption is approximately correct. In addition, these results are based on only three studies and should be interpreted cautiously. We hope that others will perform randomized clinical trials to provide additional estimates of the impact of vitamin A fortified foods.

Acknowledgements

Thanks to the following individuals for their comments and suggestions: Molly Cogswell, Glen Maberly, and Larry Grummer-Strawn.

References


**Curve Fit Explanation**

OUTPUT FROM SPSS
MODEL: MOD_5.
Dependent variable.. RATIO Method. **LINEAR**
Listwise Deletion of Missing Data
Multiple R .87964
R Square .77376
Adjusted R Square .75113
Standard Error .13220

Analysis of Variance:
DF Sum of Squares Mean Square
Regression 1 .59771976 .59771976
Residuals 10 .17476965 .01747697
F = 34.20043 Signif F = .0002

<table>
<thead>
<tr>
<th>Variable</th>
<th>B</th>
<th>SE</th>
<th>Beta</th>
<th>T</th>
<th>Sig T</th>
</tr>
</thead>
<tbody>
<tr>
<td>VITA</td>
<td>-.001247</td>
<td>.000213</td>
<td>-.879635</td>
<td>-5.848</td>
<td>.0002</td>
</tr>
<tr>
<td>(Constant)</td>
<td>.848117</td>
<td>.055134</td>
<td>15.383</td>
<td>.0000</td>
<td></td>
</tr>
</tbody>
</table>

Dependent variable.. RATIO Method. **QUADRATI**
Listwise Deletion of Missing Data
Multiple R .97517
R Square .95096
Adjusted R Square .94006
Standard Error .06488

Analysis of Variance:
DF Sum of Squares Mean Square
Regression 1 2.9986516 2.9986516
Residuals 10 .3719104 .0371910
F = 80.62833 Signif F = .0000

<table>
<thead>
<tr>
<th>Variable</th>
<th>B</th>
<th>SE</th>
<th>Beta</th>
<th>T</th>
<th>Sig T</th>
</tr>
</thead>
<tbody>
<tr>
<td>VITA</td>
<td>-.002794</td>
<td>.000311</td>
<td>-.943217</td>
<td>-8.979</td>
<td>.0000</td>
</tr>
<tr>
<td>VITA**2</td>
<td>2.82156958E-06</td>
<td>4.9477E-07</td>
<td>1.425107</td>
<td>5.703</td>
<td>.0003</td>
</tr>
<tr>
<td>(Constant)</td>
<td>.921241</td>
<td>.074093</td>
<td>12.434</td>
<td>.0000</td>
<td></td>
</tr>
</tbody>
</table>

Vitamin A in micrograms

Ratio

- **Observed**
- **Linear**
- **Quadratic**
- **Exponential**

<table>
<thead>
<tr>
<th>Ratio</th>
<th>1.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0</td>
<td></td>
</tr>
<tr>
<td>0.2</td>
<td></td>
</tr>
<tr>
<td>0.4</td>
<td></td>
</tr>
<tr>
<td>0.6</td>
<td></td>
</tr>
<tr>
<td>0.8</td>
<td></td>
</tr>
<tr>
<td>1.0</td>
<td></td>
</tr>
</tbody>
</table>

Dependent variable.. RATIO Method. **EXPONENT**
Listwise Deletion of Missing Data
Multiple R .94322
R Square .88966
Adjusted R Square .87863
Standard Error .19285

Analysis of Variance:
DF Sum of Squares Mean Square
Regression 1 2.9986516 2.9986516
Residuals 10 .3719104 .0371910
F = 80.62833 Signif F = .0000
To encourage countries to consider the fortification of flour with iron, it is useful to estimate the potential impact of flour fortification on the prevalence of anemia and iron deficiency. Many factors may affect the impact of iron-fortified flour on the prevalence of anemia and iron deficiency, including the following:

- average daily consumption of flour
- type of flour (e.g., wheat, corn)
- type of iron compound used
- incorporation of other micronutrients in the fortificant mix
- baseline levels of anemia and iron deficiency
- extraction rate (i.e., amount of bran removed from the wheat)
- diet (certain things may enhance or inhibit iron absorption)

The fortification of wheat flour with iron and other nutrients began in the United States in the 1940s. A number of other countries began similar fortification programs in the 1950s and later. While anecdotal information suggests that some of these fortification programs were associated with declines in anemia and/or iron deficiency, there has generally been no adequate baseline information to accurately estimate the impact of fortification or to assess whether declines in the prevalence might be due to other causes.

Few population-based studies have estimated the impact of iron-fortified foods on the prevalence of anemia or iron deficiency. Probably one of the best-studied situations was in Venezuela (Scrimshaw, 2001). In this study, a baseline survey was performed in 1992 and a follow-up survey in 1994. The prevalence of anemia in children from low socioeconomic strata was estimated to be 19% at baseline and declined to 9% in 1994. Likewise, iron deficiency dropped from 37% in 1992 to 16% in 1994. However, surveys in 1997, 1998, and 1999 found the prevalence of anemia to be 15%, 19%, and 17%, respectively; for iron deficiency, the prevalence estimates in these years were 14%, 11%, and 16%, respectively. (See Table D1.)

### Table D1. Results from five surveys, showing the prevalence of anemia and iron deficiency in children from the low socioeconomic strata of the Venezuelan population

<table>
<thead>
<tr>
<th>Survey Year</th>
<th>Population (N)</th>
<th>Anemia (%)</th>
<th>Population (N)</th>
<th>Iron Deficiency (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1992</td>
<td>282</td>
<td>51</td>
<td>282</td>
<td>105</td>
</tr>
<tr>
<td>1994</td>
<td>317</td>
<td>30</td>
<td>317</td>
<td>50</td>
</tr>
<tr>
<td>1997</td>
<td>590</td>
<td>86</td>
<td>571</td>
<td>80</td>
</tr>
<tr>
<td>1998</td>
<td>478</td>
<td>89</td>
<td>466</td>
<td>52</td>
</tr>
<tr>
<td>1999</td>
<td>545</td>
<td>93</td>
<td>537</td>
<td>83</td>
</tr>
</tbody>
</table>

From Scrimshaw et al., 2001.
Many factors can cause anemia, iron deficiency being only one of them. So, in general, it would seem that iron-fortified foods have the potential to reduce the prevalence of anemia; however, the level of impact will depend upon the proportion of anemia in the population that is attributable to iron deficiency. Also, the impact of iron-fortified food products would be expected to be greater if measuring iron deficiency rather than anemia (i.e., hemoglobin). Unfortunately, very few studies have been done on the impact of iron supplements or iron-fortified foods on indicators of iron deficiency.

In our early attempts to estimate the impact, we used a manuscript by Leif Hallberg (1982). Hallberg depicted an estimated relationship between increased iron absorption and its impact on anemia (Figure D1). The population from which he drew his conclusions was made up of Swedish women. For the curvilinear relationship, the upper bound of the prevalence of anemia was 30%. In attempting to apply this curvilinear relationship to populations with higher prevalences (such as 50% or 60%), the model did not appear to predict very well.

We therefore decided to base estimates of the impact of iron fortification on the results of studies of iron supplementation, to estimate a relationship for lower daily intakes of iron.

**Methods**

A review of iron supplement studies was used for this estimation process (Beaton and McCabe, 1999; see Figure D2). The data were limited to 19 studies of daily supplementation to compare the baseline prevalence of anemia with the final prevalence. The details of the studies are available in the appendices of Beaton and McCabe's document. In general, the age groups of the study groups varied; they included pregnant women or school-age children/adolescents (usually female only). The majority were based on 60mg iron/day and most included folate. A few studies provided other interventions simultaneously, such as deworming. The duration of the iron supplementation and the level of supervision of the supplement intake varied.

Because the amount of iron received daily from iron-fortified foods is generally less than the 60mg in a supplement, we assumed that the impact of lower amounts of iron on the prevalence of anemia was linear. For example, if a population had an initial prevalence of anemia of 50%, and it was estimated that a daily iron supplement of 60mg reduced the prevalence to 25%, then had only 30mg of iron been provided per day, the prevalence would be reduced to 37.5%.

**Results**

A number of features can be seen from Figure D2 (which is Figure 7.1 from Beaton and McCabe). First, there was variability between studies on the effectiveness of iron supplementation to reduce the prevalence of anemia. This level of variability was greatest in the “severe” baseline prevalence of anemia. The figure presents the regression line combining all studies. The intercept and slope of this graph were estimated as follows:

\[
\text{Final anemia prevalence} = 1 + \text{baseline anemia prevalence} \times (0.467)
\]

An example of using this formula is as follows. Assuming a population received 60 mg/day and the baseline prevalence was 50%, the final prevalence would be estimated as 24.4%:

\[
24.4\% = 1 + 50\% \times (0.467)
\]
While most studies in Beaton and McCabe’s analysis used 60mg iron supplements, there were a few that used slightly less or more iron. For our purposes, we assumed that all used 60mg iron.

To estimate the impact of less than 60mg iron/day, we used the following equation:

\[
\text{Predicted prevalence} = \text{baseline} - ((\text{baseline} - (1 + (\text{baseline} \times 0.467))) \times (\text{mg} / 60))
\]

“Predicted prevalence” is the predicted final anemia prevalence in percent; “baseline” is the baseline anemia prevalence in percent; and “mg” is the estimated daily intake of iron from the fortified product. For example, for a population with a baseline prevalence of anemia of 50% and an estimated daily intake of iron from a fortified product of 30mg:

\[
\text{Predicted prevalence} = 50\% - ((50\% - (1 + (50\% \times 0.467))) \times (30 / 60))
\]

This would estimate a final anemia prevalence of 37.2%. Table D2 presents the predicted final anemia prevalence for a variety of baseline prevalences and iron intake.

Figure D3 shows this data in graphical form.

<table>
<thead>
<tr>
<th>Baseline Prevalence of Anemia (%)</th>
<th>Iron intake (mg/day)</th>
<th>1</th>
<th>5</th>
<th>10</th>
<th>20</th>
<th>30</th>
<th>60</th>
</tr>
</thead>
<tbody>
<tr>
<td>60</td>
<td>59.5</td>
<td>57.4</td>
<td>54.8</td>
<td>49.7</td>
<td>44.5</td>
<td>29.0</td>
<td></td>
</tr>
<tr>
<td>50</td>
<td>49.6</td>
<td>47.9</td>
<td>45.7</td>
<td>41.5</td>
<td>37.2</td>
<td>24.4</td>
<td></td>
</tr>
<tr>
<td>40</td>
<td>39.7</td>
<td>38.3</td>
<td>36.6</td>
<td>33.2</td>
<td>29.8</td>
<td>19.7</td>
<td></td>
</tr>
<tr>
<td>30</td>
<td>29.8</td>
<td>28.8</td>
<td>27.5</td>
<td>25.0</td>
<td>22.5</td>
<td>15.0</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>19.8</td>
<td>19.2</td>
<td>18.5</td>
<td>16.8</td>
<td>15.2</td>
<td>10.3</td>
<td></td>
</tr>
</tbody>
</table>

Values presented in the table are the predicted final anemia prevalence estimates (%).
Ideally, estimates of the impact of iron-fortified foods should be based on randomized clinical trials, and the outcome should be the reduction of iron deficiency. Unfortunately, only sparse data are available, and therefore iron supplement studies were used in this document. It is possible that there is no linear relationship between daily iron dose and a reduction in the prevalence of anemia. The studies selected varied on a number of factors, such as age, duration of intervention, and perhaps quality of data collection/supervision. Therefore, these results should be interpreted cautiously. It is hoped that others will perform more definitive clinical trials to improve the estimates of the impact of iron-fortified foods on reducing the prevalence of iron deficiency and anemia.

Issues

On the first page of this document a number of factors were listed that likely impact the effectiveness of iron fortification. Some other issues that might affect this document's estimation procedure are described below.

Reasons why the approach taken in this document might underestimate the effect of iron fortification:

- The curve might not be linear. There are data to suggest that around 50 mg of iron or more as a supplement might not affect, to any great extent, the final prevalence of anemia. This suggests that the “true” response curve may fall below those depicted in Figure D3, at least for the higher levels of daily iron intake.
- It has been suggested that small amounts of iron in fortified foods consumed daily over a long period of time may have a more beneficial effect than the curves presented in Figure D3. This might involve issues of pharmokinetics and cumulative dose.
- Using anemia as the endpoint likely understates the effect of iron fortification on iron deficiency.

Reasons why the approach taken in this document might overestimate the effect of iron fortification:

- Fortified foods are consumed with a meal that may include inhibitors that might reduce the impact of the iron.

Acknowledgements

Thanks to the following individuals for their comments and suggestions: Molly Cogswell, Glen Maberly, Richard Hurrell, and Larry Grummer-Strawn.

References


Annex E
The PROFILES Model: Underlying Principles and Assumptions

by Bienvenido Alano

The PROFILES model developed by the Academy for Education Development in collaboration with USAID (Ross and Aguayo, 2001) has been adapted and modified for the purpose of assessing the economic benefits and costs of fortification in the Country Investment Plans (CIPs). This short annex discusses the underlying principles and assumptions used. The annex has three main sections. The first presents the composition of the PROFILES model—i.e., the worksheets and calculations used in the benefit-cost assessments. The second section deals with the measurement of the stream of costs and benefits associated with the fortification projects in the CIPs. The last section discusses the different benefit-cost indicators used.

The PROFILES Spreadsheets

Adapting and using the PROFILES model to come up with a sound assessment of the various fortification projects required a coordinated effort between the Country Teams—which generated most of the data inputs—and the members of the consulting team tasked with developing the model. Much preparatory work was needed to gather, verify, and complete all the necessary information. Equally demanding were efforts to validate the soundness of the assumptions used by the model. As a rule, we used the more conservative assumptions. (Note this later, for example, in the parameters used for productivity losses for blue-collar and heavy manual labor.)

The process is illustrated in Figure E1. The first steps involved gathering the data needed to drive the model. This was done primarily by the Country Teams and covered three major areas: (1) the prevalence of micronutrient deficiency, (2) the demographics of the target populations, and (3) the costs and economic parameters. The data served as introduced into the calculations for estimating the benefits from fortification (e.g., lives saved, productivity gains, and health care costs saved), as well as the costs. The cost data were mainly derived from industry studies that were undertaken to estimate private production costs, food control costs, nutrition monitoring costs, and social marketing costs, among others.

In PROFILES, the results of the various activities, from Country Teams’ data preparation to industry studies, were introduced into the various worksheets. The worksheets included in PROFILES are listed in Table E1.

Four worksheets provide the major inputs for the model. These include $I_{Prev}$, malnutrition...
prevalence, 2Dem, the demographic variables, and 3Rel, other related inputs, as well as 11 FortifCosts, the cost input worksheet. For the 3Rel worksheet, three types of information were gathered:

1. mortality variables
   • estimates of infant mortality and under 5 mortality rates, maternal mortality ratio, and relative risk of mortality for those with micronutrient deficiency
2. economic variables
   • labor force, wage, and national income accounts data
   • used in estimating productivity impacts of the fortification project
3. morbidity variables
   • costs of clinic attendance and hospital admissions, and relative risks of morbidity for those with micronutrient deficiency
   • used to estimate the impact of the fortification project on health care costs

The remaining worksheets are model calculations. Filling in the information in the input worksheets automatically yields the benefit-cost assessment indicators. The next sections attempt to explain how the model does this.

For some country studies, there may be a need to add further refinements and modifications to the worksheets, depending on the type of food vehicles and unique data requirements. It is also interesting to note the variance in estimates for a number of these input variables across countries, particularly the population, average earnings, health care costs, and other morbidity variables in 3Rel, which could lead to significant differences in the resulting estimates of benefits and costs across these countries.

### Measuring the Streams of Costs and Benefits for the Fortification Projects

#### Estimating the Stream of Costs

For costs, the estimation procedure is straightforward but still rather laborious. The cost estimates should cover whatever costs are incurred in carrying out the project, including (1) those incurred by private producers (the costs of micronutrients, energy, capital, labor, and other costs over the lifetime of the project) and (2) those incurred by government (including social marketing, food control, and nutrition monitoring). These are presented in the worksheet 11 FortifCosts of the PROFILES spreadsheet.
Estimating the Stream of Benefits

Estimating the benefits from fortification is much more complicated, in the sense that benefits are more difficult to discern and quantify. Economic benefits from fortification arise from averting the economic costs of the micronutrient deficiencies. In general, the costs of micronutrient deficiencies are measured in terms of (1) higher mortality, (2) higher morbidity, and (3) lower productivity. Accordingly, the benefits from fortification are derived from a reduction in the prevalence of micronutrient deficiency, which results in:

- a reduction in mortality (lives saved),
- reduced morbidity (translated to health care cost savings), and
- increased productivity.

In particular, vitamin A, iron, and folic acid deficiencies are found to have profound impacts on these three outcomes.

Vitamin A Deficiency (VAD)

For vitamin A deficiency (VAD), the most serious effects are for children under 5 years old. In particular, the relative risk of mortality and morbidity has been found to be considerably higher for this age group with VAD. (See Ross and Aguayo (2000) for a detailed discussion of the effect of VAD on mortality and morbidity.)

For this project, we used the relative risk estimate of mortality for children under 5 years old with VAD from the original PROFILES model of Horton and Ross, which is approximately 1.75. This means that the risk of mortality for children with VAD is 1.75 times the risk of mortality for children without VAD. This implies that vitamin A fortification that leads to a reduction in VAD prevalence would result in lives saved.

While the number of lives saved is enough indication of the benefits of fortification, the model attempts to quantify such benefits to allow their inclusion in benefit-cost calculations. Toward that end, the economic benefits from lives saved are measured by what those individuals are expected to produce and contribute to the gross national product. This is estimated as the present value of average earnings during gainful employment, assumed, on average, to be age 16-50. Gainful employment could last beyond age 65. However, not all individuals will survive up to retirement age. The shortened period of gainful employment is used as an approximation of the average number of years of gainful employment. The benefit estimate is also adjusted for unemployment. The estimation process for lives saved and productivity gains is found in 4VADmort of the PROFILES spreadsheet.

In terms of morbidity, children under 5 years old are more likely to seek treatment at clinics and hospitals. Again we use the estimates from the Horton and Ross study, which are 1.19 and 1.84, respectively, for the relative risk of clinic attendance and the relative risk of hospital admission, both for children under the age of 5. Thus, VAD for children under 5 years old results in:

- Increased clinic attendance. Thus, reduced morbidity because of fortification would mean benefits arising from reduced clinic attendance and consequently health care cost savings (i.e., a reduction in health care costs).
- Increased hospital admission. Similarly, reduced morbidity because of fortification would also mean reduced hospital admissions and thus savings in the costs of hospitalization.

These estimates are included in worksheet 5VADmorb of the PROFILES spreadsheet. Figure E2 illustrates the process flow for estimating the benefits from VAD reduction.

Iron Deficiency Anemia (IDA)

For iron deficiency, the most serious impacts are on mortality and productivity losses. Again, refer to Horton and Ross (2001) and Ross and Aguayo (2000) for a detailed discussion of the effects of iron deficiency and anemia on mortality and productivity. Pregnant women carry the greatest mortality risk. Studies find that approximately 22.6% of maternal

72 There is some discussion about whether to net out the increased consumption with survival. Increased consumption means increased demand, which translates to a contribution to GNP. The approach here is not to net out consumption and consider the whole future earnings as an addition to GNP.
deaths are due to IDA. A reduction in IDA prevalence from fortification is therefore expected to reduce maternal deaths. This is estimated in worksheet 6 IDAmort of the PROFILES spreadsheet.

Productivity losses come from two sources:

1. lifetime (irreversible) productivity losses from cognitive losses arising from having IDA from 6 months to 2 years of age, and
2. reversible productivity losses for blue-collar and heavy manual labor.

Productivity losses due to anemia for less physically demanding labor are assumed to be minimal and are thus not measured.

For lifetime productivity losses IDA is found to result in a 0.5 standard deviation drop in cognitive scores, which Horton and Ross (2001) estimate to result in irreversible productivity losses of about 4%. The lifetime productivity loss from cognitive losses due to IDA is thus taken to be 4% of future earnings, which is estimated as the present value of average wages during gainful employment, again assumed, on average, to be age 16–50.

In the case of reversible productivity losses for blue-collar labor, Horton and Ross estimated additional loss due to adult anemia among blue-collar workers to be about 1%. For heavy manual labor, the estimate of additional loss due to adult anemia among heavy manual laborers is approximately 12%.

The productivity losses are estimated in worksheet 7 IDA Pdty of the PROFILES spreadsheet.

The process flow for generating these estimates is presented in Figure E3.

Folic Acid Deficiency

We used a different approach to measure the benefits of folic acid fortification, given the lack of robust data on folic acid deficiency (FAD) prevalence and the relative risks involved for those with FAD. The study by Tice et al. (2001) looked at the impact of grains fortification on coronary heart disease (CHD). The model makes use of the results of this study as indicated below.

The benefits arise from two main sources:

- reduction in births with Neural Tube Defects (NTD) and
- reduction in the CHD event rate.

Births with NTD are estimated to be reduced by approximately 30% with grain fortification of 140 µg of folic acid per gram of grain. Honein et al. (2001) estimates the prevalence of births with NTD to have declined by about 19% in the United States since folic

acid fortification was made mandatory in 1998—from 37.8 per 100,000 live births before fortification to 30.5 per 100,000 live births conceived after fortification. In Canada, Ray et al. (2002) estimates a larger decline of about 48% in the early- to mid-trimester prevalence of NTDs with folic acid fortification, from 113 to 58 per 100,000 pregnancies. We chose to use a lower rounded average of a 30% reduction. This implies:

- children's lives saved and
- economic benefits gained (estimated, as in the case of VAD in children, as the present value of future earnings).

The estimation is done in worksheet 8 FADmort.

In the case of CHD:

- The US Food and Drug Administration, since January 1998, has required the fortification of enriched grain products with 140 µg of folic acid per 100 grams, a level found to decrease the homocysteine level, which has been identified as a risk factor for CHD.
- Tice et al. (2001) predicted that folic acid grain fortification would reduce CHD events by 8% in women and 13% in men, with comparable reductions in CHD mortality.
- As such, the benefits arise from a reduction in health care costs due to the reduction in number of CHD cases, and thus hospital admission and clinic attendance.

This estimation is done in worksheet 9 FADmorb.

Summary of Results

Finally, the results from the benefit-cost assessments are summarized and put together in the worksheets on BCsum and IRR, which provide benefit-cost ratios, net present values, and internal rate of return for the project. These measures ultimately indicate the overall desirability (or nondesirability) of each project. These concepts are explained further in the following section.

Benefit-Cost Indicators Used

A number of indicators could be used to assess the desirability of a project. Among the more widely used are:

1. benefit-cost ratio (B/C),
2. net present value (NPV), and
3. internal rate of return (IRR).

These indicators are calculated by the PROFILES model. They are basically the same, in that they attempt to weight the benefits against the costs of a project. All three need to estimate the stream of benefits and costs over the lifetime of a project.

Benefit-Cost Ratio (B/C)

The benefit-cost ratio directly compares benefits against costs. Clearly, if B/C > 1, then benefits outweigh costs and the project is desirable. If B/C < 1, the benefits from the project would only be a fraction (less than 1) of the cost of the project. The costs would then outweigh the benefits, and the project would thus be undesirable.

Net Present Value (NPV)

For net present value, the stream of benefits and costs are discounted to bring them to present values, using a discount rate that represents how much future costs and benefits are valued compared with the present. This is important because a unit value now (e.g., a dollar now) is valued differently than a dollar in the future (e.g., next year). Specifically, a dollar now is more valuable than a dollar next year. The discount rate represents how much more the dollar is worth now compared with the future. What this means is that we cannot simply and directly add benefits (or subtract costs) occurring at different time periods. We need to discount them first to their present value to make them comparable and additive.

Thus, if B represents the present value of the stream of benefits of a project (i.e., the sum of the stream of properly discounted benefits), and similarly, C represents the present value of the stream of costs of the project, then the NPV is simply B – C. Hence,
the NPV is basically accomplishing the same end as the B/C ratio—weighing benefits against costs.

In the NPV criterion, a project is desirable if B – C > 0. That is, the project is desirable when benefits are greater than costs.

This is exactly the same as the B/C ratio, if the B and C in the B/C ratio are properly discounted before being summed up. The B/C ratio could be estimated yearly, but a one-year estimate would not accurately indicate the desirability of a project on the whole (over its lifetime). The B/C ratio estimated for a normal, representative year could, of course, be a good approximate.

**Internal Rate of Return (IRR)**

The internal rate of return measures the rate of discount that makes a project break even (NPV = 0). What does such a measure indicate? Using a discount rate that is anything less than the IRR in evaluating a project would make the NPV of the project positive. In essence, finding that rate of discount where the NPV becomes zero is an accounting measure of how much returns could be attributed to capital. Whether this return is good enough or not is the next thing to determine.

If the IRR is greater than the social rate of discount, r, (usually measured by the opportunity cost of capital), then the capital invested in the project is earning more than its opportunity cost. In addition, if the IRR is greater than r, then the NPV of the project is positive (>0). As such, benefits would outweigh costs. Hence, the IRR criterion, IRR > r, is the same as the NPV criterion, NPV > 0, and B/C criterion, B/C > 1, in assessing the desirability of a project.

In the PROFILES model, the projects use a 10-year time frame. This would tend to underestimate the benefit-cost ratio and the IRR since the capital investment is expected to last longer. This follows our general guideline of being biased towards conservative assumptions.

**References**


Annex F
Product Profiles

The profiles on the following pages offer snapshots of ten of the fortification projects proposed in the CIPs. Each profile includes the rationale for, background, and current status of the project. These profiles may prove useful to analysts in making easy comparisons or in summarizing projects for colleagues.

Indonesia Flour Fortification with Iron and Folic Acid

**Background:**
- Limited but rising consumption
- Centralized production (5 mills)
- Mandatory standards
- Implementation ongoing

**Ten-Year Plan:**
- Phase-out premix subsidy
- Build government food control and customs enforcement
- Improve nutrition surveillance capacity
- Partner with consumer groups to raise demand among low income consumers

*Cost of iron and folic acid only. Program includes other vitamins and minerals.*

<table>
<thead>
<tr>
<th>Ten-Year Cost</th>
<th>USD million</th>
</tr>
</thead>
<tbody>
<tr>
<td>Est. Donor Participation</td>
<td>20%</td>
</tr>
<tr>
<td><strong>Ten-Year Benefits</strong></td>
<td></td>
</tr>
<tr>
<td>DA Reduction (consumers)</td>
<td>24%</td>
</tr>
<tr>
<td>VA Productivity Gains</td>
<td>14%</td>
</tr>
<tr>
<td>PAV: Saved Income Health Care</td>
<td>$10 million</td>
</tr>
<tr>
<td>Deaths Averted</td>
<td>111,000</td>
</tr>
<tr>
<td>Benefit-Cost Ratio</td>
<td>6.1</td>
</tr>
</tbody>
</table>

Pakistan Flour Fortification

**Background:**
- High consumption among poor
- Large mill/maker share 50% and rising
- Product trials complete
- Ongoing collaboration of MOH and flour mills (PFMA)
- Awarded $3 million GAIN grant

**Ten-Year Plan:**
- GAIN 5-Year Plan: Conclude legislation and expand to all roller mills
- CIP 10-Year Plan: Expansion into small-scale sector; Proposing 2-year multi-district trials and capacity building project.

<table>
<thead>
<tr>
<th>Ten-Year Cost</th>
<th>USD million</th>
</tr>
</thead>
<tbody>
<tr>
<td>Est. Donor Participation</td>
<td>20%</td>
</tr>
<tr>
<td><strong>Ten-Year Benefits</strong></td>
<td></td>
</tr>
<tr>
<td>DA Reduction</td>
<td>10%</td>
</tr>
<tr>
<td>VA Productivity Gains</td>
<td>$20 million</td>
</tr>
<tr>
<td>PAV: Health Care &amp; Earnings Saved</td>
<td>$7 million</td>
</tr>
<tr>
<td>Deaths Averted</td>
<td>30,000</td>
</tr>
<tr>
<td>Benefit-Cost Ratio</td>
<td>2</td>
</tr>
</tbody>
</table>

Indonesia Palm Oil Fortification with Vitamin A

**Background:**
- High consumption among poor
- Strong national industry
- Central production (57 plants)
- Vitamin A stability and effectiveness issues

**Ten-Year Plan:**
- Consumption data collection by KFI mid 2004
- UNICEF efficacy trials to be completed by early 2005
- Multilateral roundtable planned for 2004
- After product development, CIP proposes model to mandate

<table>
<thead>
<tr>
<th>Ten-Year Cost</th>
<th>USD million</th>
</tr>
</thead>
<tbody>
<tr>
<td>Est. Donor Participation</td>
<td>22%</td>
</tr>
<tr>
<td><strong>Ten-Year Benefits</strong></td>
<td></td>
</tr>
<tr>
<td>VAD Reduction in Children</td>
<td>14%</td>
</tr>
<tr>
<td>Deaths Averted</td>
<td>44,000</td>
</tr>
<tr>
<td>Saved Earnings/Health Care</td>
<td>$66 million</td>
</tr>
<tr>
<td>Benefit-Cost Ratio</td>
<td>11</td>
</tr>
</tbody>
</table>

Pakistan: Oil Fortification with Vitamin A

**Background:**
- High consumption among poor
- Central production (217 units)
- Current mandatory legislation
- 50% plus noncompliance

**Ten-Year Plan:**
- Advocacy to all sectors regarding potential impact
- Build 'public-private oversight facility' with flexible goals for producer compliance
- Build capacity for monitoring and large-scale social marketing
- Initiate limited time bound producer incentives and subsidies

<table>
<thead>
<tr>
<th>Ten-Year Cost</th>
<th>USD million</th>
</tr>
</thead>
<tbody>
<tr>
<td>Est. Donor Participation</td>
<td>22%</td>
</tr>
<tr>
<td><strong>Ten-Year Benefits</strong></td>
<td></td>
</tr>
<tr>
<td>VAD Reduction</td>
<td>28%</td>
</tr>
<tr>
<td>Line Saved</td>
<td>42,000</td>
</tr>
<tr>
<td>Saved Health Care &amp; Earnings</td>
<td>$130 million</td>
</tr>
<tr>
<td>Benefit-Cost Ratio</td>
<td>3.9</td>
</tr>
</tbody>
</table>
### PRC Soy Sauce with Iron

**Background:**
- High consumption
- 200 large plants produce 30% with increasing market share
- Product development complete
- Pricing issues with new packaging
- Awarded a $3 million GAIN grant

**Ten-Year Plan:**
- GAIN 5-Year Plan: phased expansion to 200 plants in 3 years
- Raise quality and safety standards via market license system
- Social marketing and targeting distribution to poor

### Thailand Flour Fortification with Iron and Folic Acid

**Background:**
- Limited but rising consumption
- Centralized production at 8 large mills

**Ten-Year Plan:**
- Project tax and tariff reductions on inputs
- MOPH nutrition seal endorsement and social marketing campaign
- 90% industry participation in 3 yrs

### PRC Flour Fortification with Iron and Folic Acid

**Background:**
- High consumption in northwest
- Increasing share of large mills
- Product development complete
- Effectiveness trials ongoing
- Awarded $3 million GAIN grant

**Ten-Year Plan:**
- GAIN 5-Year Plan: Expand NW province public distribution project
- CIP 10-Year Plan: Expand to mandatory national strategy
- Propose higher quality standards to enhance centralized production
- Social marketing to target low income segments

### Viet Nam Fish Sauce with Iron

**Background:**
- High consumption among poor
- 70% produced in 30 facilities
- Partial government ownership
- Extensive product trials complete
- MOH product standards being finalized
- Awarded $3 million GAIN grant

**Ten-Year Plan:**
- GAIN funded 5-year plan: Achieve 70% fortified market share.
- CIP 10-year plan: Consolidate production and expand to reach 90% national consumption

### Thailand Fish Sauce with Iron

**Rationale:**
- High consumption
- 20 plants with 85% market share
- Product development complete
- Cooperation of National Fish Sauce Manufacturers Association secured

**Ten-Year Plan:**
- Expand to 20 plants in 3 years
- Project 85% product fortified within 3 years
- MOPH nutrition seal endorsement and social marketing
- Project tax and tariff reductions on inputs

### Viet Nam Flour Fortification with Iron and Folic Acid

**Rationale:**
- High IDA prevalence
- Rising consumption
- Central and modern production at 16 mills

**Ten-Year Plan:**
- Implement efficacy trials to initiate food regulatory p required by government of Viet Nam
- Potential for collaboration with other ASEAN countr regional public and private organizations.
### Annex G
Glossary

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>atta flour</td>
<td>unrefined brown flour</td>
</tr>
<tr>
<td>chakki mills</td>
<td>small-scale stone mills serving local communities</td>
</tr>
<tr>
<td>complementary foods</td>
<td>semisolid foods fed to infants and very young children as a complement to breast-feeding or commercial or homemade formula, as a means of better meeting the nutritional requirements of the child</td>
</tr>
<tr>
<td>ferritin</td>
<td>an iron-containing protein complex that functions as the primary form of iron storage in the body, used as an indicator of iron deficiency</td>
</tr>
<tr>
<td>HAACP</td>
<td>(Hazard Analysis and Critical Control Point) — a food-safety program used by the US Food and Drug Administration that focuses on preventing hazards that could cause food-borne illnesses by applying science-based controls, from raw material through to finished products</td>
</tr>
<tr>
<td>hemoglobin</td>
<td>the iron-containing respiratory pigment in red blood cells, used as a biochemical indicator of anemia</td>
</tr>
<tr>
<td>homocysteine</td>
<td>an amino acid (a building block of protein) that is produced in the human body. At high levels, homocysteine may irritate blood vessels, leading to blockages in the arteries. Most people with high homocysteine levels do not have enough folic acid or vitamin B₆ or B₁₂ in their diets</td>
</tr>
<tr>
<td>NaFeEDTA</td>
<td>(sodium iron ethylenediaminetetraacetic acid) — a highly absorbable iron compound that can be used as a fortificant in brown flours, soy sauce, and fish sauce</td>
</tr>
</tbody>
</table>
## Annex H
### Acronyms

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Full Form</th>
</tr>
</thead>
<tbody>
<tr>
<td>µg</td>
<td>micrograms</td>
</tr>
<tr>
<td>mg</td>
<td>milligrams</td>
</tr>
<tr>
<td>ADB</td>
<td>Asian Development Bank</td>
</tr>
<tr>
<td>ASEAN</td>
<td>Association of Southeast Asian Nations</td>
</tr>
<tr>
<td>CAPM</td>
<td>Chinese Academy of Preventive Medicine</td>
</tr>
<tr>
<td>CHD</td>
<td>coronary heart disease</td>
</tr>
<tr>
<td>CIP</td>
<td>Country Investment Plan</td>
</tr>
<tr>
<td>DULOG</td>
<td>the national food distribution agency in Indonesia</td>
</tr>
<tr>
<td>FAD</td>
<td>folic acid deficiency</td>
</tr>
<tr>
<td>FAO</td>
<td>Food and Agriculture Organization of the United Nations</td>
</tr>
<tr>
<td>GAIN</td>
<td>Global Alliance to Improve Nutrition</td>
</tr>
<tr>
<td>GMP</td>
<td>good manufacturing practices</td>
</tr>
<tr>
<td>GRET</td>
<td>Group D'Exchange et de Recherche Technologique</td>
</tr>
<tr>
<td>HACCP</td>
<td>hazard analysis and critical control point</td>
</tr>
<tr>
<td>IDA</td>
<td>iron deficiency anemia</td>
</tr>
<tr>
<td>IRR</td>
<td>internal rate of return</td>
</tr>
<tr>
<td>IU</td>
<td>international unit</td>
</tr>
<tr>
<td>JFPR</td>
<td>Japan Fund for Poverty Reduction</td>
</tr>
<tr>
<td>MDG</td>
<td>Millennium Development Goal</td>
</tr>
<tr>
<td>MOH</td>
<td>Ministry of Health</td>
</tr>
<tr>
<td>MOPH</td>
<td>Ministry of Public Health</td>
</tr>
<tr>
<td>MT</td>
<td>metric tons</td>
</tr>
<tr>
<td>NaFeEDTA</td>
<td>sodium iron</td>
</tr>
<tr>
<td>NGO</td>
<td>nongovernment organization</td>
</tr>
<tr>
<td>NPV</td>
<td>net present value</td>
</tr>
<tr>
<td>NTD</td>
<td>neural tube defect</td>
</tr>
<tr>
<td>ppm</td>
<td>parts per million</td>
</tr>
<tr>
<td>PRC</td>
<td>People's Republic of China</td>
</tr>
<tr>
<td>RDA</td>
<td>recommended daily allowance</td>
</tr>
<tr>
<td>RDI</td>
<td>recommended daily intake</td>
</tr>
<tr>
<td>SAARC</td>
<td>South Asian Association for Regional Cooperation</td>
</tr>
<tr>
<td>SSOP</td>
<td>sanitation standard operating procedures</td>
</tr>
<tr>
<td>USAID</td>
<td>US Agency for International Development</td>
</tr>
<tr>
<td>USDA</td>
<td>US Department of Agriculture</td>
</tr>
<tr>
<td>VAD</td>
<td>vitamin A deficiency</td>
</tr>
<tr>
<td>VWU</td>
<td>Viet Nam Women's Union</td>
</tr>
<tr>
<td>WHO</td>
<td>World Health Organization</td>
</tr>
</tbody>
</table>