Plenary Session 1
WHY WE ARE HERE

Overview

Vitamin A, iron, or iodine deficiencies affect 30 percent of the world's population. Some 735 million persons suffer from the clinical forms of these deficiencies, and another two billion from subclinical forms. Collectively, they damage health; cause death; harm reproduction; reduce intelligence, educability, and academic achievement; and lower work productivity and occupational choices. Of special concern, micronutrient deficiencies interfere with child growth and development, sometimes permanently.

The consequences of micronutrient malnutrition are serious in both the short and long term: current health and productive activities are harmed, and the potential of future generations will be damaged. Micronutrient deficiencies play a major role in mortality risk as well, especially for pregnant mothers and young children, through influence on height, size, and proper functioning of the immune system. IDD, protein energy malnutrition (PEM), and iron deficiency anemia (IDA) have substantial negative impacts on developmental capacities of children, probably in that order of significance. Malnutrition is not just a public health problem: it holds back economic development. Micronutrient malnutrition, with its insidious effects over the life span of the child, will cost the economy at least 3 percent of GDP annually. This translates into a staggering sequence of losses in growth and human potential. From the perspective of human rights, access to nutrition is a child's right. Article 24 of the Convention on the Rights of the Child underscores the right to the highest attainable standard of health and the right to adequate nutrition and the right to nutritious foods. Action is needed now.

Cost-effective nutrition interventions are available and should be used more consistently. Food fortification could also be the most assured and least-costly strategy to correct iodine, vitamin A, and iron deficiencies. Food fortification offers a long-term, effective, and sustainable solution to the elimination of the problem within an integrated strategy that also includes supplementation, dietary change, and diversified household and homestead production. This could improve the population-wide IQ by 10-15 points, reduce maternal deaths by one third, decrease infant and child mortality by 40 percent, and increase work capacity by almost half.

Fortification serves the need of the public sector to reduce malnutrition early in life to reduce chronic adult disease, support safe motherhood, and sustain economic growth through human capital improvement. The private food industry has equally compelling reasons for shifting production to fortified foods if they are profitable. Raising product quality through fortification will stimulate demand for regional products, and intensify competition and trade within and

beyond the region. Economies of scale for fortified foods, as competitors follow product leaders, will lower prices and reach new consumers.

Food-based solutions to micronutrient malnutrition will be achieved through the organized production, marketing, and distribution of foods by private and public food companies. This obviously requires a major regional effort to shift public resources toward public-private sector partnership to promote fortification of staples and complementary foods for infants, and this deserves extensive discussion. Support for food fortification is consistent with the twin pillars of sustainable development under the ADB mandate: poverty reduction and catalytic support to the private sector. The role of government will be equally important in providing the guidelines and laws that will permit fortification, ensure quality assurance, and guarantee that the consumer receives the intended nutrients at the levels prescribed. This is a proper use of public resources because it has a preventive health thrust and will allow people's needs to be both felt and informed. Both producers and consumers need to be fully informed about the minimal change to production or purchasing decisions in order to shift preferences and demand for fortified foods. The technical costs of production are not prohibitive.

Additionally, the potential of the food industry to create nutritious foods for young infants has yet to be tapped in the region. For the food industry in Asia and the Pacific, complementary food vehicles are at the cutting edge of product development and social marketing strategy, especially for the lower-income groups. Countries risk a "lost generation" unless they improve nutrition for under-twos, the stage of life when the body and brain experience maximum growth potential. The importance of adequate iron, vitamin A, and iodine nutrition during this period, combined with continued breastfeeding after six months, cannot be overestimated for the child's prospects as a student, as a worker, and as a citizen.

Active collaboration with the public sector will be the key to making fortification a more attractive option to the food industry. If private food companies are to reach their full potential in contributing to elimination of micronutrient malnutrition, a new paradigm of partnership with the public sector needs to be developed. This should include raising the importance of fortified food products, joint marketing and public education campaigns, seals of approval, minimizing costs-sharing risks and rewards, keeping "mark-ups" to a minimum, regulations, quality assurance, and reaching specific populations at risk.

Today an unparalleled opportunity exists for government, private food companies, and public agencies to work together to ensure adequate intake of micronutrients for people all over the world. To define an activist and expanded role for the private sector we need to establish clear, open, and ongoing lines of communication between company managers and public officials. We need to share experience, to gain trust, and to define mutually acceptable roles that capitalize on the relative strengths of each sector.

What is urgently needed is to identify a set of priority actions and initiate a continuous dialogue between the various sectors to move quickly toward the implementation of schemes that will permanently eliminate malnutrition. Specifically, a multisectoral partnership needs to be built between industry, national

governments, international agencies, expert groups, and other players, to work closely on specific issues relating to technology development, food processing and marketing, free-market approaches with minimum price support mechanisms, standards, quality assurance, product certification, social communications, and demand creation, monitoring, and evaluation. Guidelines on these issues should then gain acceptance and be implemented at the country level. A multisectoral group within each country should define a feasible affordable strategy designed for the target population, identify opportunities for the involvement of the food industry, and assist in promotional and educational efforts to reach the target population.

Public-Private Partnerships for Nutrition and Human Development: the Asian Development Bank's Perspective

Ms. Christine Wallich
Director, Infrastructure, Energy, and Financial Sectors Department (West Asia) and concurrent Head, Private Sector Group
Asian Development Bank

This meeting is compelling beyond description because we are addressing why enormous human potential is being lost when clear solutions are readily available. As development specialists, business leaders, and investment planners, we cannot justify the loss of life and the chronic disabilities of mind and body that micronutrient deficiencies impose on most nations in Asia and the Pacific. Others will detail the nature of this crisis for us, so that we can return to our places of work with a deep commitment to change the situation for the better. My role is to look squarely at the problem and start to see the way forward, with your help and insights.

As I look out at this distinguished assembly of leaders in the food industry and the public health service from the region and beyond, I am struck by the thought that the Manila Forum could be the beginning of the solution to a chronic nutrition problem associated with poverty. The region accounts for three quarters of the world's malnutrition problem. Asia is the Big Show. If we solve it here, the world will literally be a different place.

Malnutrition holds back economic development in a major way, and that is inexcusable in a recovering region that is anxious to rejoin the world's leaders in sustained growth. In an era driven by knowledge rather than muscle, the region will either be capable of orchestrating a new architecture of learning or simply fall behind the world's leaders. The Asian children of the millennium can be full of potential for life-long learning and productivity, but not if they are afflicted with what we call "hidden hunger". By the end of this Forum, I think the problems will be clearer to us, and so will the potential solutions.

I appreciate the high cost to each of you in leaving your leadership role back home to join us for three days. But you have come because you sense that Asian and Pacific countries must work together to become a global manufacturing and trading force in the food industry. I also suspect that you are idealistic competitors, eager to be successful and serve the public good at the same time. I know you share our hope that a collective vision will emerge from this Forum that will guide our actions as a region in the future.

The Asian Development Bank (ADB) has recast its mandate to reflect what we call the twin pillars of sustained development: poverty reduction and catalytic support to the private sector. The old adage that wealth can buy health has a more profound flip side: health makes wealth when human capital is enriched at minimal cost. I am obviously not a nutrition specialist, but the social and economic benefits of eliminating micronutrient deficiencies far outweigh the public and private investment costs. Lives, intact mental faculties, and earning capacity for the poor lie in the balance. So let's see if we can answer these four questions to our satisfaction:

What do we know?
What do we need to know?
What light can we shed on the way forward?
How can ADB help?

WHAT WE KNOW

We know that the public and private sectors must work together or the problem will not be solved. This meeting will build upon successful partnerships and the lessons learned that can be applied regionally. The stunning success story of iodized salt's movement throughout Asia in the 1990s needs to be understood and replicated with other widely consumed staples.

We know that the solution to eliminating iodine, iron, and vitamin A deficiencies is primarily a challenge for industrial policy, not health policy in the narrow sense. The private sector has been the vehicle for improving the quality of widely consumed foods in the industrialized countries, with the public sector creating a fair and transparent regulatory frame. Unless there is an enabling environment for the private sector to improve dietary quality through market-based solutions, the problem will persist and place a chronic drag on economic growth. The key is to create an environment in which private companies can see the economic potential of food fortification programs and capture some of the vast benefits their participation helps create.

Lastly, we know that we have to change the pattern of discourse in the region. Lack of transparency is injurious to business confidence, inimical to trade prospects, and unlikely to strengthen Asian leadership in the food industry. The Forum is the first step forward.

The strategic advantages of fortification are irresistible, despite widespread inertia. Fortification does all of the following:

- harnesses new resources;
- requires modest investment;
- shifts the fiscal burden from the State to private firms and households;
- is more cost effective than public health supplementation programs;
- builds on existing technology that can be rapidly adopted in a business-friendly environment; and
- is facilitated by the globalization of the food industry, where science-based knowledge and decision making are virtually instantaneous.

There is also a moral issue. At the World Summit for Children (1990) all the governments in the region proclaimed that most micronutrient deficiencies would be eliminated by 2000, and that is still far from happening. When Dr. Hill of UNICEF informs us that nutrition security should be based on fundamental human rights, he touches a chord in us all.

WHAT WE NEED TO KNOW

Four issues that need addressing come to mind.

First, we need to discuss candidly with each other what the obstacles are to moving properly fortified products forward in the region. As you know, this kind of discussion is often avoided. Aside from salt, Asia has fallen behind Latin America and the Caribbean in fortifying staple foods, and "Produced in Asia" lacks resonance with the international business community. Whether it's lack of knowledge or lack of trust, Dr. Maberly's notion of "sharing risk and reward" is important.

Second, we need to explore ways to create a regional "learning laboratory" for the exchange of information, results of research, and transfer of technology concerns, so that today's cutting-edge options will be adopted quickly and consistently within the food industry. This will strengthen the competitiveness of fortified foods within and between countries.

Third, we need to involve the consumer and women's movements in our dialogue so that we know that we are responding to people's felt needs. The educated and informed Asian woman is the key decision maker who will determine the physical and intellectual development of children, and without her involvement in the transition to fortified foods, industry will simply continue to produce high-value food vehicles in small quantities for the middle class. The poor would then be priced out of the "dietary revolution". The positive slant is that the public sector can help create demand among the poor using social marketing techniques perfected by industry.

Fourth, we need to look closely at the problems faced by governments in creating and administering regulatory environments favorable to fortification, particularly what is feasible in the poorer countries where governments' capacity to deliver is strictly limited. The international framework is equally important. What do the codes of international business practice and the new rules of trade under the WTO mean to the food producer and consumer in today's global marketplace? How can we harness the global information revolution? How can we make sure the same standards

apply to exported foods as apply to food produced for the domestic market?

The expertise is in this room to address all these issues, and we will leave wiser for the opportunity to share that expertise with one another.

THE WAY FORWARD

What is urgently needed is to identify a set of priority actions and initiate a continuous dialogue between the various sectors in order to move quickly toward the implementation of schemes that will permanently eliminate malnutrition. Specifically, a multisectoral partnership needs to be built among industry, national governments, international agencies, expert groups, and other players. Partners need to work closely on specific issues relating to technology development, food processing and marketing, free-market approaches with minimum price-support mechanisms, standards, quality assurance, product certification, social communications, and demand creation, monitoring, and evaluation. Guidelines on these issues should then gain acceptance and be implemented at the country level. A multisectoral group within each country should define a feasible affordable strategy designed for the target population, identify opportunities for the involvement of the food industry, and assist in promotional and educational efforts to reach the target population.

This coalition will benefit private-sector partners, not just as a lever to improve performance in the marketplace, but also to show that the private sector has social as well as economic interests. It will benefit the government, which has a mandate to improve the lives of people. And it will allow national and international development agencies to provide technical support and seed investment in an efficient way.

This coalition should help government to understand better how to engage the private sector; to build an environment in which food producers with good products, consistent quality, and honest packaging can build brand image, market share, and public recognition. Also, in the same environment, poor products, misleading labeling, and bad business practices must be properly exposed.

The basic challenge is to bridge the communications gap between the public and private sectors in understanding their needs and respective roles and responsibilities. While constraints and shortcomings do exist, there is no need to delay immediate action. We expect that the Forum will produce a consensus statement on a regional action plan.[1]

ADB'S ROLE

As a regional financial institution, ADB sees fortification as a win-win situation for governments, producers, and consumers, and a good example of how human development and economic growth are mutually reinforcing. Here are five possible roles that ADB can fulfill in moving the fortification agenda forward on a regional level.

1. *Prepare a regional feasibility study through technical assistance support to some of the governments participating in the Forum*. ADB will seek your wisdom on the scope of this regional study, which will look at both the needs of the public and private sectors in the region. The study, when completed in 2001, will form the basis for discussion on priorities for investment.

2. *Mobilize resources and possibly provide loans*. ADB will hold a regional investors' roundtable based on the regional feasibility study, and will seriously consider its role in meeting financing gaps within individual countries. There are many possibilities that we can discuss during the course of the Forum. ADB's role can certainly include lending to the public sector to help create the regulatory environment, raise public awareness, and support research. For example, multicountry lending for a core "menu of options", such as quality assurance laboratories for the public health service for the salt and flour industries.

[1] The Forum's Consensus Statement is included at the beginning of this report.

Central Asia might be a good example where both industrial and regulatory practices can be upgraded and the trade environment modernized with the application of WTO notions of discipline. ADB may also assist in funding private companies on a commercial basis to help them meet demand for fortified products and attain higher quality standards. ADB would seek to play a catalytic role, to help mobilize private capital, and would only participate when the right environment has been created for profitable private-sector participation. We might work through financing vehicles suitable for reaching small and medium agribusiness, for example an equity investment fund. Some linkage between public- and private-sector lending may also be possible in order to build sustained public-private sector partnerships.

3. *Engagement with the international philanthropic foundation network for sustained poverty reduction in Asia and the Pacific*. The recent beneficence of the Gates Foundation to support the Asian Vaccine Initiative inspires us to look for broader partnerships than the usual donor community, and ADB would be happy to assist this dialogue.

4. *Agricultural research and extension for micronutrient-dense staples* (rice in particular) is an area that ADB intends to support. The potential for broad agro-industrial partnerships for elimination of malnutrition is in its infancy, but ADB may be a useful broker at the regional level.

5. *Joining hands with the United Nations community*. ADB considers that this is important in order to ensure that dialogue on governance and rights-based programs are complementary. Perhaps our UNICEF and WHO colleagues would like to expand on the possibilities.

The Asia-Pacific region is on the verge of a second green revolution that will focus on dietary quality for the poor and others. The private sector will lead the way, and ADB will do what it can to support them. ❐

Why Children Have the Right to Live Without Micronutrient Deficiency

Dr. Terrel Hill
Country Representative
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Thank you Mr. Chairman. It is a pleasure to address this gathering on behalf of UNICEF. Originally Mr. Kul Gautam, our regional director for East Asia and the Pacific, was invited to speak to you. Mr. Gautam has since been appointed Deputy Executive Director of UNICEF and will take over the post in New York starting on 1 April 2000. He apologizes that he could not be here.

I would like to thank the Micronutrient Initiative and ADB for the invitation to UNICEF to continue with the present partnership. I would like to thank Ms. Wallich for setting the stage for my message, which in some ways is very narrow and in some ways is very broad.

For the past decade, since the Convention on the Rights of the Child (CRC) was ratified, it has become universal international law; it has become the basis for what we call rights-based programming. In some respects, the Convention revolutionizes the way we think about the various problems that beset children throughout the world. For example, Article 24 of the Convention binds 191 governments in the world to provide "the highest attainable standard of health and the right to adequate nutrition and the right to nutritious foods".

Article 28 of the CRC is very clear that children have a right to education, and to attain the highest possible level of education and learning in their lives. Article 19 talks about freedom from abuse and exploitation that come in many forms, such as child labor, sexual exploitation, and other types of exploitation. Articles 12 and 13 talk about freedom of expression: that children have the right to think, the right to form opinions, and to express those opinions and participate in decisions that affect their lives.

We have found over the past decade in trying to program for child rights that it is hard to work for any single right, because the rights are so intertwined. For example, in child labor, we find that it is not just the case of a right of the child not to undergo hazardous labor; usually these children are in hazardous labor because they dropped out of school and therefore their right to education is not being honored. And they drop out from school because of ill health or malnutrition. They were not able to keep up. Therefore, after a few years of schooling they dropped out and can never catch up.

Thus, the central message, which we believe is so compelling, is that micronutrient malnutrition is not just a nutrition problem. It is an education problem, a right-to-expression problem, a right-to-be-free-from-fear problem.

About 22 years ago, I first visited Sengi, in Central Java, Indonesia, just as we were beginning to combat micronutrient malnutrition, specifically IDD, which was severe in the Sengi region. I remember in particular one family devastated by IDD. The father was very short in stature. Both father and mother were mentally retarded because of lack of iodine. However, their son, who was 18-years old at the time, was tall, normal, very bright, and has since become a doctor. His parents' generation was "lost" due to a simple lack of iodine.

We live our lives only once. A child is a child only once. The micronutrients must be there today. This is the compelling urgency of our meeting today: we can take years to develop policy and to get private-public sector partnerships going. But while we do that, we have the risk of one more generation being afflicted. As I look at my own family, my sons are all six-feet tall, while I am obviously not. Also, my sons like to think that they are smarter then me and perhaps they are. I believe that this is the impact of micronutrient supplementation. My children grew up in an era of fortified foods. But they also had their vitamin and mineral supplements that their mother insisted they take. My personal conviction is that the combination of these things, a good varied diet,

supplementation, and food fortification to high standards, allows them to meet their potential.

UNICEF is eager that micronutrient malnutrition end with this generation and become history. We pledge to help as best we can in this partnership. We are already working in a private-public sector cooperative activity even here in the Philippines. But I am sure that today there remains a Sengi in every country. You may say no, no, we don't have cretins. But do you have an iron-deficient Sengi? There is likely to be an iron-deficient Sengi in our neighborhood.

People with low hemoglobin levels; those who wake up in the morning tired; those whose productivity at work is not as it could be. These are signs that there is likely to be a Sengi everywhere in Asia. It is our hope in UNICEF that we can work together in a partnership that will mean that one can visit Sengi, Indonesia, or the other Sengis of Asia and focus on the beauty of the land and the strength and vitality of the children. But this can only happen if we can really put together effective, strong, public-private sector multi-agency cooperation.

I believe, after working in this area for the last 20 years, that fortification science is strong. As we develop policies on food fortification, we must apply the science effectively. It is the management and the financial and economic issues that need more work. ❐

The Role of the Private Sector in Reducing Micronutrient Malnutrition

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I am very pleased to be with you today to discuss how we all can work together to combat micronutrient deficiencies in Asia. The International Life Sciences Institute (ILSI), with its global network of food company members and technological resources, would like to be a partner in this endeavor. ILSI was formed in 1978 to unite the food industry to collectively sponsor research on food safety and nutrition, and to support global partnerships of scientists across different disciplines, sectors, and geographies. ILSI is a public, nonprofit foundation supported by industry, private foundations, and government funding. It has a membership of 400 companies and an international network of over 3,000 scientists. ILSI has a global presence with 15 branches around the world. These branches facilitate cooperation among regulators, scientific organizations, and industries.

ILSI facilitates cooperation between scientists from academia, government, industry and the public sector. We have NGO status with WHO and FAO and we collaborate with UNICEF, other NGOs, and the private sector to improve public health throughout the world. It is this type of broad-based collaboration that is so desperately needed to combat micronutrient deficiencies. Our experience as an organization, our member companies, and our participating scientists can make a critical difference for developing intervention strategies to combat micronutrient malnutrition.

For more than 15 years now, ILSI's Human Nutrition Institute has been the secretariat for the International Vitamin A Consultative Group (IVACG) and the International Nutritional Anemia Consultative Group (INACG); these groups are supported by the US Agency for International Development (USAID). Last March in Durban, South Africa, the IVACG meeting was attended by 600 health professionals from 66 countries. A one-day satellite INACG Symposium was also held to review current issues on iron deficiency and anemia prevention.

In early 1997, ILSI launched the project IDEA of action to eliminate iron deficiency. Its mission is to work with government agencies in some key countries to fortify staple foods and condiments with iron. The reason for starting this project was that whereas a great deal of effort had gone toward eliminating iodine and vitamin A deficiencies, no concerted effort had been made to eliminate iron deficiencies.

As you will hear at this Forum, ILSI is already working in the People's Republic of China (PRC) on a soy sauce fortification program, in Viet Nam and Thailand on fish sauce, in India on double-fortified salt (iodine + iron), and in the Philippines on wheat flour double fortified with vitamin A and iron.

ILSI, together with CDC, Emory University, and MI, will sponsor a major conference entitled Forging Effective Strategies to Combat Iron Deficiency. It will take place on 7-9 May 2001 in Atlanta, Georgia. The conference will review current intervention strategies and case studies in order to identify strengths and limitations in nutrition programs. The conference will provide a forum for researchers from all over the world to report on findings to date. An outcome of the conference will be to develop a research agenda on how to overcome micronutrient malnutrition in Asia. It could also be a follow up to this Manila Forum to review the progress to date of the program that we agree to undertake.

THE PRIVATE-SECTOR ROLE

In the early part of the 20th century, private chemical and pharmaceutical companies in Europe and North America synthesized and developed many

of the nutrients used today as dietary supplements or as added nutrient premixes to foods. And it was the food processing industry that developed ways to incorporate vitamin and mineral additives without affecting food quality. Of course, private food companies did not make this progress in isolation. They reacted to pressure from the health community and from consumers; and they responded to new standards and regulations from governments.

Today in Asia, food-based solutions to micronutrient malnutrition will be achieved through the organized production, marketing, and distribution of foods by private and public food companies. Of course, the role of government will be equally important in providing the guidelines and laws that will permit fortification and that will guarantee that the consumer receives the intended nutrients at the levels prescribed.

To make this a reality in Asia, an active research program must be undertaken at the country level to determine the extent of the deficiencies and then to find the best food vehicle and the most bioavailable and stable micronutrient to use.

In Europe and North America, private companies have been making an impact on micronutrient deficiencies for many years through food fortification. The following are a few examples.

In the early 1900s in Denmark, there was a high incidence of children with xerophthalmia, the night blindness that results from VAD. Fortification of margarine with vitamin A alleviated this deficiency and xerophthalmia disappeared. In addition, rickets, a result of vitamin D deficiency, was widespread throughout Europe and North America until milk and margarine were double fortified with both vitamins A and D.

In the US, pellagra caused more than 3,000 deaths annually during the 1930s. However, in 1938 bakers began enriching bread with a range of vitamins and minerals including niacin. In a matter of years, deaths from this micronutrient deficiency all but disappeared. Prior to 1943, the population of Newfoundland suffered from multiple micronutrient deficiencies. In that year, wheat flour was fortified with thiamin and riboflavin. Selected population groups were assessed in 1944 and again in 1949. The results demonstrated that in just four years, thiamin and riboflavin deficiencies were virtually eliminated.

In the 1950s in the US, 90 percent of infant formula was not fortified with iron, and the prevalence of iron deficiency in children was about 30 percent. Through fortification, iron deficiency dropped to less than 5 percent. More recently, flour fortification in Venezuela has shown impressive results. After two years of wheat and corn flour fortification, iron deficiency in children was down from 37 to 15 percent.

Fortification of sugar with vitamin A in countries of Central America such as Honduras has demonstrated equally significant results. In Honduras, the prevalence of VAD decreased from 40 to 13 percent after sugar fortification began.

Over the last 20 years, major progress has been made in reducing iodine deficiency through the use of iodized salt. By 1998, 93 countries practiced salt iodization.

Fortification has become an industry best practice and the marker of a quality product. But today, half of the world's population still remains affected by micronutrient deficiencies. As we look for a remedy in the 21st century, it is clear that the private sector will continue to play a major role. The success story of iodine fortification of salt should be the model used to fortify staple foods and condiments with vitamin A and iron and other micronutrients such as zinc and folic acid.

The private sector understands how to build consumer demand and deliver the products that consumers want. Food companies have collected a vast body of knowledge relating to consumer preferences and habits. Industry's communication networks for the delivery of consumer messages are unparalleled. Their distribution infrastructure can deliver products to the most congested urban cities, as well as to the most remote mountain villages.

Based on market research and experience, the private food industry understands that in many countries nutrition is not always at the top of the list of consumers' priorities. Selling nutritional benefits is not only informing consumers about good health. Messages need to tap into what consumers want—their hopes, their dreams, and their aspirations for their families.

While many food companies focus their products and marketing on the more well-to-do segments of the population, it is important to remember that this access and information are also relevant to the less-advantaged sectors of society. Extensive advertising of processed foods that are fortified and available to the affluent will, in the long run, create a market demand for better nutritional products that can eventually be made affordable to the less affluent.

The private sector responds quickly and flexibly to consumer needs and to opportunities in the marketplace. Today in industrialized countries in Asia such as Japan and the Republic of Korea, companies are marketing a range of functional foods and fortified products in response to the health consciousness of consumers. However, these are not available to mass markets in other countries where micronutrient deficiencies may be of grave concern. As the commercial benefits of fortification become apparent, companies will innovate in order to capitalize on that opportunity. They will develop new food products, more efficient processes, more extensive distribution networks, and expand their marketing messages. Let me focus briefly on two examples of industry's innovation and response.

Vitamin Markets. Today, in the developed world, synthetic vitamins such as vitamin A have been produced mainly to supply the markets for supplements, for food products, and animal feed. However, the market for nutrient additives in developing nations has been small. Opportunities are now arising to fortify staple foods such as rice, wheat, and sugar with vitamin A. Vitamin companies are working hard to develop new forms of vitamin A that are more stable under conditions found in less developed countries. Also, as fortification in the developing world becomes more widespread and the sales volume increases, the price of fortificants such a vitamin A and iron EDTA will undoubtedly go down.

The Role of Biotechnology. Biotechnology presents another opportunity to deliver the needed micronutrients. For instance, new rice strains already have been developed with much higher levels of beta carotene; consumption of this rice could significantly reduce VAD. Other varieties of rice could be developed with high levels of iron or lower levels of phytates, a major inhibitor of iron absorption.

Also, new soybean seeds can be developed with high levels of iron, vitamin A, and even calcium. While innovations offer great promise for future global needs, each new variety must be thoroughly tested for safety and environmental impact. Therefore, it is estimated that it will be at least five years from now before any of these seeds are extensively used.

DEVELOPING AN EXPANDED ROLE FOR THE PRIVATE SECTOR

Private companies are always scanning the horizon for new market opportunities. We have to remember that an investment in fortification competes with other investment opportunities. If Asia clearly offered a market for fortified products, then private investments would follow these opportunities. However, when we talk about micronutrient malnutrition we are talking about an invisible hunger, without the force of consumer desire or demand. Therefore, the investment may be high and the payback relatively slow compared to other investment opportunities, unless consumer demand for fortification is stimulated through public education campaigns.

Collaboration Between the Public and Private Sector

Active collaboration with the public sector may be the key to making fortification a more attractive option to the food industry. I believe that if private food companies are to reach their full potential in contributing to elimination of micronutrient malnutrition, a new kind of partnership with the public sector needs to be developed.

I would like to take this opportunity to lay out some broad ideas for a new role that the private sector might play in a collaboration with governments, NGOs, and international agencies. These entities share a common goal: raising the importance of fortified food products.

Raising the Importance of Fortification: Social Marketing

If consumers today were aware of how much they needed micronutrients and understood the difference between fortified and unfortified products, private food companies would already be working hard to satisfy their demands. However, the economic reality is that, whether it be salt, flour, or some other fortified food, consumers, (particularly those most at risk), when faced with choosing between a fortified product and a slightly cheaper alternative, will choose the latter. This is the rational choice unless information intervenes to raise the perceived value of the more expensive product.

Using the health data generated by the public sector and the consumer research resources of the private sector, public and private organizations can work together to build awareness of micronutrient malnutrition and create demand for fortified products.

In addition to public education campaigns there are other potential collaborative strategies. A private company vouching for the efficacy of its own product can be suspect in the eyes of the consumer. Public agencies and NGOs, however, have high credibility. Public and private organizations should work together to establish and document the efficacy of specific fortified products in reducing micronutrient deficiencies. These trials can then be used to clarify and validate health claims.

I think that a seal of approval, such as the *Sangkap Pinoy* Seal offered by the Department of Health in the Philippines is a promising way of supporting fortified products. The Program is a food fortification strategy to encourage food manufacturers to add essential nutrients, namely vitamin A and iron, to their products at significant levels. To qualify for the Seal the food item must be fortified with 1/3 of the recommended daily allowance (RDA). Seals from trusted third-party sources, such as a Ministry of Health, are a marketing strategy to build consumer demand for fortified products. Enforcement of quality standards is also important to ensure that the consumer receives the quantity of nutrients specified on the label. This Program could be expanded for use in other countries of Asia.

Minimizing Costs: Sharing Risks and Rewards

The flip side of raising consumer demand and product value is keeping price to a minimum. The cost of fortification is not high—usually 1-3 percent of the cost of the product. Often this is less than the rate of inflation. However, these costs are real and can be daunting. For example, a cost of $1.00[2] per tonne to fortify flour may not appear high to those of us not in the milling industry. But to a miller who produces 100,000 or 200,000 tonnes per year, and whose profit margin is $2.00 per tonne, it represents a significant cost increase. Likewise consumers, especially those most at risk for micronutrient deficiencies, can be very sensitive to price. Research and market experience has shown that when presented with a 1-3 percent difference in price, consumers will choose the less expensive option. So, while working together to raise the value of fortified products, governments and industry also need to work together to minimize the increased costs.

Process technology, quality assurance, and monitoring can contribute to increased costs beyond the costs of the fortificant itself.

Every company has targets for returns on investment, anywhere from 15 to 40 percent. A key to keeping costs of fortification down is to regard these investments differently, with looser criteria for return on investment. With regard to fighting malnutrition, companies need to become philanthropic and develop a desire to help consumers become healthier as a result. Perhaps the timeline for payback can be stretched or the targeted return can be lowered.

Governments must provide incentives to industry to encourage fortification. For instance, they could dispense with tariff on imported fortificants, which may range from 5 to 35 percent. Also, they could eliminate excise tax or VAT, which can add 10 to 20 percent more to the retail cost.

[2] Unless otherwise specified, $ means US$ throughout.

These two items alone can turn an incremental cost of, for example, $1.00 per tonne for flour, to nearly $1.50.

Country by country, public agencies and private companies need to examine the cost structure of fortified food products and work together to minimize and share these costs in ways that reflect their partnership, joint commitment, and mutual goal, which is the elimination of micronutrient malnutrition.

Regulations and Quality Assurance

Whether fortification regulations are voluntary or mandatory, they must be evenly and strictly enforced so that companies that take the risk and invest in fortification are rewarded in the market place. A significant demand for the fortified product will, in the end, offset the increase in production costs.

Reaching Specific at-Risk Populations

While fortified staple foods and condiments may reach the broad bulk of the population, some sectors still may not be covered. Targeted supplementation may be the answer. Government and industry can work together to develop new distribution channels aimed at specific populations at risk. Such channels could include the public welfare systems or the school system. We also should double our efforts to develop affordable micronutrient-rich complementary foods for those most at risk—the youngest children.

I believe that today an unparalleled opportunity exists for government, private food companies, and public agencies to work together to ensure adequate intake of micronutrients for people all over the world. The devastating impact of micronutrient malnutrition on individuals and on nations is well documented. Most governments have nutrition plans of action that specify micronutrient deficiencies as priority areas for action. Food production is becoming increasingly centralized. Consumption patterns are shifting to more processed and packaged foods. Markets in developing countries are providing unprecedented opportunities for private investment in new products and technologies. Major initiatives in fortification cannot happen overnight; comprehensive programs must be undertaken in every country to determine the most appropriate food vehicle or condiment for delivering the key micronutrients.

To define an activist and expanded role for the private sector we need to establish clear, open, and ongoing lines of communication between company managers and public officials. We need to share experience, to gain trust, and to define mutually acceptable roles that capitalize on the relative strengths of each sector. ❐

Food Fortification as a Major Strategy to Address Micronutrient Malnutrition in Asia

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BACKGROUND

Deficiencies in three micronutrients—iodine, iron, and vitamin A—are widespread, affecting more than a third of the world's population. In their absence, individuals and families suffer serious consequences including learning disabilities, impaired work capacity, illness, and death. These deficiencies can be prevented and even eliminated if small quantities of the micronutrients are consumed by populations on a continuous and ongoing basis. Several delivery mechanisms are available, ranging from high-dose supplements to consumption of micronutrient-rich foods to public health measures.

Short-term strategies for micronutrient malnutrition control, such as high-dose supplementation, have been effective in providing immediate relief in several countries, but there is concern that these strategies are not sustainable in the long term. Here, food fortification could play an important role to meet the need for a nutrient in a population that is apparent from dietary, biochemical, or clinical evidence. Food fortification is the addition of nutrients to commonly eaten foods so as to maintain or improve the quality of diet of a community. Fortification should be viewed as part of a range of measures that influence the quality of food; others include improved agricultural practices, improved food processing and storage, and consumer education to adopt good food preparation practices.

Food fortification involves the identification of commonly eaten foods that can act as vehicles for one or more micronutrients and lend themselves to centralized processing on an economical scale in a country or region. Fortification, when imposed on existing food patterns, may not necessitate changes in the customary diet of the population and does not call for individual compliance. It could often be dovetailed into existing food production and distribution systems. For these reasons, fortification can often be implemented and yield results quickly and be sustained over a long period of time. It can thus be the most cost-effective means of overcoming micronutrient malnutrition. The objective of this presentation is to highlight international experiences in fortification, its impact in alleviating micronutrient deficiencies in large populations, and possible approaches to develop effective programs.

The concept of nutrient fortification of staple foods was developed in the early part of this century as a means of dealing with mineral- and vitamin-deficiency diseases that were prevalent in Europe and North America. Salt was iodized in Switzerland in the early part of the century. Margarine fortified with vitamin A was introduced in Denmark in 1918. During the 1930s and 1940s, milk was fortified with vitamin A and flour was fortified with iron and B vitamins in a number of European countries and in North America. In developed countries where there is a high dependence on processed foods and industries are streamlined and automated, food fortification has played a major role in the health of the populations at large over the last 40 years and several nutritional deficiencies have been eliminated.

Over the past decade, the contribution of salt iodization toward the virtual elimination of IDD in several developing countries has been substantial. Bolivia and Ecuador are now IDD free. In some African countries (Nigeria, Madagascar, Eritrea, Cameroon), salt iodization levels are higher than 80 percent. Food fortification has also played a major role in substantially reducing vitamin A and iron-deficiency anemia. A national sugar fortification program in Guatemala has virtually eliminated VAD as a public health problem in that country. Flour fortification in Chile and Venezuela

is substantially improving iron status in all sectors of the population. Today, in Latin America, Asia, and Africa, consumers of fortified products as varied as margarine, milk, noodles, and corn starch are substantially protected from a range of micronutrient deficiencies.

Based on more than 50 years of experience, food fortification has been proven effective in the control and prevention of a number of micronutrient deficiencies. Let us look at some examples.

In the US, after the introduction of flour fortified with niacin in 1938, deaths from niacin deficiency dropped from more than 3,000 per year to negligible levels in approximately a decade (Fig. 1). The current low levels of IDA in the US are attributable to fortified sources. Almost 1/4 of iron intakes in the US diet comes from fortified sources, much of that from flour products.

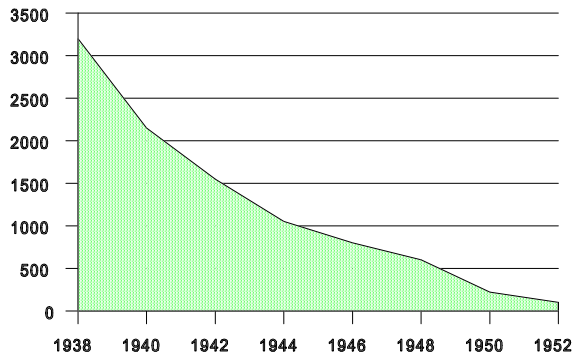

Figure 1. US Mortality from Niacin Deficiency. Bread Fortification Began in 1938.

Flour fortification with B vitamins began in Newfoundland during 1944. Within four years, deficiencies that were found in nearly 20 percent of the population dropped to negligible levels (Fig. 2). In fact, Newfoundland was so convinced of the benefits of mandatory fortification that it made continuation of flour fortification a condition of the charter when it joined the Canadian federation.

In past decades, flour fortification has been implemented in a number of Latin American countries. Chile has an IDA rate of less than 1 percent, which most observers attribute to a strong flour fortification program. More recently, all corn and wheat flour in Venezuela was fortified with iron, vitamin A, and B vitamins. Fortified to a level of 20-30 ppm, flour products currently contribute about 48 percent of the RDA for iron in the average Venezuelan.

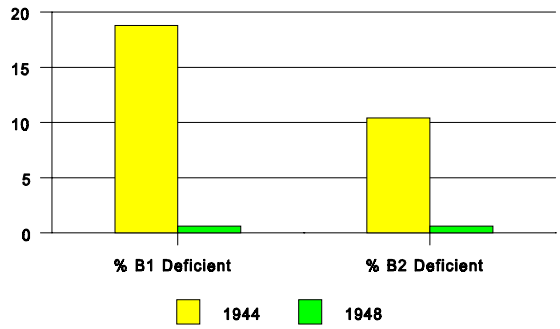

Figure 2. Vitamin B Deficiency in Newfoundland (percentage of population). Flour Fortification Began in 1944.

The impact of flour fortification in Venezuela has been both swift and dramatic. Studies of anemia in children living in Caracas slum areas during the years immediately before and after fortification indicate that anemia rates were reduced by about a factor of 2.5 as a result of fortification (Fig. 3). It is important to note that this dramatic improvement occurred during a period when no other nutrition interventions were taking place and more importantly, a time when economic pressures were causing an overall decline in the quality of the diet among the poorer classes of the country.

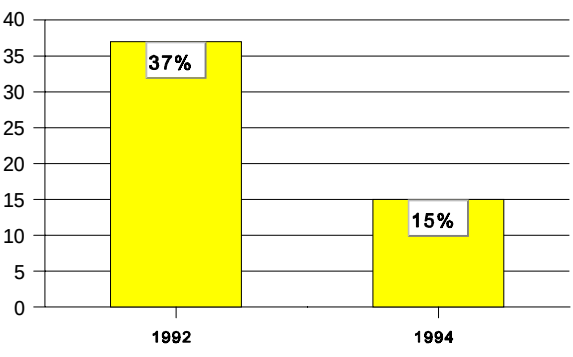

Figure 3. Anemia in Children in Caracas, Venezuela (percentage). Flour Fortification Began in 1993.

Food fortification cannot expect to reach all populations deficient in essential micronutrients. When access to commercially or centrally processed food is limited due to geography, poverty, or cultural preference, public health and welfare approaches to deliver supplements or dietary education are often the only viable options. However, for the large and expanding populations of all socioeconomic classes that regularly purchase and consume commercially processed foods, fortification can make an enormous difference. Fortification offers the following strategic advantages.

Fortification harnesses new resources. By building on existing food production and distribution infrastructure, fortification engages the market system and the private food sector. Industry provides much of the initial investment and ultimate financing is borne by consumers. The private sector also offers technical expertise in production and marketing and, most importantly, a business-like approach to solving problems.

Fortification requires modest investment. Capital investment in fortification technology is minimal and easily absorbed by the producer. Ongoing costs of fortificant, marketing, and quality assurance are usually absorbed in the normal market fluctuations for most foods. Incremental costs are often as low as 1-2 percent and are either passed along to the consumer or simply absorbed by the producer. In Thailand, fortification added 0.05 percent to the cost of a pack of noodles. This was not discernible to the consumer, who experienced a price increase of 15-20 percent due to inflation.

Fortification is cost effective. Fortification reaches broad populations at minimal cost. In Guatemala, sugar fortification protects the entire population for less than one fourth the cost of supplementation. In Peru, a fortified school breakfast program offers protection against micronutrient deficiencies at a cost of $0.98 as compared to$1.52 for supplementation and $3.63 for dietary promotion.

Fortification builds on existing technology. For many industries all over the world, the addition of conditioners, preservatives, vitamins, and minerals is not new. The additive equipment is already integrated into the process flow.

Fortification is facilitated by globalization of the food industry. Technology is rapidly becoming global with expanding trade and investment. Fortificants, premixes, and processing knowledge are now available internationally.

Fortification supports other public health strategies. With fortification reaching the bulk of the population, government can focus supplement delivery and dietary education on remote and disadvantaged populations with limited access to fortified foods.

Fortification enhances sustainability. Fortification, when integrated into the food processing and distribution system, becomes a permanent feature and can be sustained with little external support or investment.

The technical considerations in planning a food fortification program are

i) the food vehicle should be consumed by a sizable proportion of the population;
ii) the fortified product should be inexpensive so that it is consumed by the low-income groups, which are more vulnerable to malnutrition;
iii) the food vehicle should be processed centrally in large enough units to permit controlled fortification—a factor that limits consideration of home-grown foods;
iv) the product should be distributed through a widespread network so that it reaches all parts of a country;
v) there should be no change in taste, appearance, or color on fortification;
vi) there should be no loss of the nutrient on further processing/cooking of the food; and
vii) the vehicle should be consumed in fairly constant amounts so that fortification levels can be accurately calculated. There should be little chance of some people

consuming large amounts of the fortified vehicle as might occur with softdrinks or snack foods.

The selection of a suitable vehicle and fortificant that meets all these conditions is often difficult. Salt iodization is one example of successful large-scale fortification in the developing world, the primary reason being the simple and low-cost technology and the narrow band of salt consumption quantities within a given region or population. There exist several other opportunities for single and multiple fortification of several commonly eaten foods like wheat and wheat products, rice, milk and milk products, cooking oils, salt, sugar, cereals, and condiments. As processed foods gain popularity in the developing world with an increasing market outreach, they offer new channels for micronutrient delivery.

Depending on the food processing technologies, different addition methods have been developed:

- Dry mixing for cereal flours and their products, milk powder, powder beverages
- Dissolution in water for liquid milk, drinks, fruit juices, and in the water to be used for making bread, pastas, and cookies
- Spraying, as in iodization of salt and corn flakes, where the vitamins do not support the cooking or extrusion step
- Dissolution in oil for the liposoluble vitamins for enrichment of oily products like margarine
- Adhesion for sugar fortification where a vegetable oil is used to adhere the vitamin A in powder form to the sugar crystal
- Coating, as in rice, where the vitamins sprayed over the grain must be coated in order to avoid losses when washing the grains before cooking.

Research and development efforts have enhanced the effectiveness of fortification technology. The stability of iodine compounds in salt has been significantly improved by better refining procedures and packaging. In the case of iron, stabilizers and absorption enhancers are added along with the fortificant to retain it in an absorbable form or improve absorption. The structure of the iron compounds has been modified to improve absorption. In the case of vitamin A, work to retard the loss of potency during storage is continuing. In all these cases, there is room for further improvement and refinement for better product stability and absorption, and for lowering costs. Development efforts need to continue.

Over the past decade, considerable experience has been gained in the planning and implementation of fortification programs in the developing-country context, using support measures like advocacy and social communication, legislation and enforcement, monitoring and evaluation, and training. Given this background it would be useful to review global experience in food fortification with micronutrients—both successful and not successful—to assess the quality of available technologies and identify opportunities and challenges in their application. In addition, we need to understand the programmatic considerations that have a bearing on the large-scale application of the technologies.

MAJOR MICRONUTRIENTS

Iodine

Over the past decade, salt iodization has witnessed a remarkable growth in application. A significant proportion of the populations in over 110 countries already has access to iodized salt and many countries are progressing toward the goal of universal salt iodization (USI). Once established in the country, salt iodization is a permanent solution to the problem. Iodine dosages range from 20 to 100 mg/kg of salt depending upon per capita salt consumption and anticipated iodine losses between production and consumption. These losses are dependent upon the quality of salt and packaging. Toxicity issues are negligible and cost considerations fairly small.

While considerable progress has been made in streamlining control programs through salt iodization

in several countries, producer compliance, quality assurance, logistic problems, and bottlenecks do remain. The challenge is to identify and tackle these constraints systematically through effective advocacy, social communications, monitoring of salt iodine levels, regulation, and enforcement.

Salt iodization was the first large-scale experience in national fortification of a commodity. It has provided valuable lessons in collaboration between government, industry, NGOs, the media, and other sectors. It has also given insights into building and sustaining an intervention politically, technically, financially, and culturally.

Iron

While iron has the potential for use in more food vehicles than iodine or vitamin A, fortification with iron is technically more difficult than with other nutrients since iron reacts with several food ingredients. In the case of iodine and vitamin A, the problem is more that of stability of the added compound under different storage and cooking conditions. The biggest challenge with iron is to identify a form that is adequately absorbed and yet does not alter the appearance or taste of the food vehicle. The buff-colored, insoluble, iron phosphate compounds are stable under a variety of storage conditions but are poorly absorbed. Soluble iron salts like ferrous sulfate are well absorbed but easily discolor when reacting with food ingredients.

In addition to the general fortification criteria, iron fortification needs to take into account certain specific considerations:

i) the vehicle should be a component of all meals because absorption varies inversely with the iron content of the meal;
ii) it should not require prolonged storage, particularly under hot and humid climatic conditions, since this could cause organoleptic problems;
iii) vehicles that are dark or have a strong taste or odor permit the use of more reactive iron compounds; and
iv) segregation of iron should not occur during mixing or storage.

While salt is clearly the mainstay for long-term iodine deficiency prophylaxis, reducing the global prevalence of iron-deficiency anemia will require the use of several alternative fortification compounds and food vehicles depending upon the local dietary patterns. Some promising possibilities follows.

Wheat flour and bakery products. In developed countries like the US, Sweden, and Canada, these foods have had significant success as vehicles for iron. Stability problems have been largely overcome by using certain forms of reduced elemental iron. The bioavailability of iron added to wheat flour is several times greater than that when added to other staple foods such as maize and rice. Further, the use of elemental iron ensures its even meal distribution and provides a reasonably constant iron supply to each individual. More recently, Venezuela, Ecuador, Brazil, and several other Latin American countries are implementing universal fortification programs for wheat and corn flour with iron, vitamin A, thiamin, riboflavin, and niacin.

Rice. Rice is a logical choice because it is a staple food for more than half the world's population and the main component of the diet in many countries where nutritional anemia is highly prevalent. Efforts in iron fortification of rice have been made since 1949 in the Philippines. In Papua New Guinea, a formulation that includes iron with vitamin B is used. It is noteworthy that in spite of these attempts there is still no large-scale program in operation. The Micronutrient Initiative has been working in Indonesia to integrate iron and/or vitamin A into the "matrix" of broken rice grains that are powdered and reconstituted into full grains to produce a premix. The premix is then mixed with the rice in a certain proportion. Rice fortification is certainly an area that needs further work to develop a product that would be acceptable, and in which the iron would resist both washing and cooking and yet rapidly disintegrate in the intestinal tract. From the point of view of large-scale application, it will be necessary to examine patterns of rice processing, availability of centralized milling points, and feasibility of large-scale fortification.

Salt. The technical requirements for iron fortification of salt are much more stringent than for

iodine. Development efforts in India over the past 22 years have produced some positive results. During the mid 1970s, a combination of ferrous sulfate with stabilizers like sodium acid pyrophosphate and a pH controller like sodium acid sulfate was tested extensively both in the laboratory and in field trials. The fortified salt showed good bioavailability and stability. This product is now commercially produced in limited quantities by a few companies in southern India but needs extensive promotion and government support.

In 1984, when the policy of universal iodization of salt was announced in India, the focus of work shifted to developing a formulation that would permit the addition of both iodine and iron. This is because the acidic medium in which the iron compound is stable causes the rapid oxidation of iodide/iodate to free iodine, which vaporizes and is lost. In order to overcome this problem two approaches show promise:

- The National Institute of Nutrition, Hyderabad, has reported a formula using ferrous sulfate, a polyphosphate chelating agent (as stabilizer) and potassium iodate/iodide. This is reported to be stable even in impure grades of salt.
- Recent work at the University of Toronto supported by the MI has shown the feasibility of producing a dextrin encapsulation technique that provides a barrier between the iron and iodine compounds and improves stability. The salt is currently being field tested in Ghana for efficacy and consumer acceptability.

The successful testing and large-scale application of available technology for the double fortification of salt could represent a major breakthrough for combined iron and iodine delivery.

Condiments. In Thailand, fish sauce that is consumed in many parts of the country has been tested as a vehicle for iron. Fish sauce fortified with NaFeEDTA has shown good hemoglobin response. Fish sauce and fish paste have also been used as vehicles in the Philippines. Curry Powder used by an Indian population in South Africa has been fortified with NaFeEDTA with successful results. In the PRC, the feasibility of using soy sauce as a carrier for iron is being examined. However, all these studies have been only pilot trials and the constraints that retard large-scale application have not been identified.

Processed foods. There is a growing trend in several developing countries to increasingly use processed foods such as noodles, cereals, and soup cubes. Weaning foods for children are also becoming popular. Elemental iron of small particle size is being used for the fortification of processed cereals in several developed countries. In Chile, chocolate cookies have been fortified with dried hemoglobin for distribution as part of a school lunch program with good improvement in hemoglobin levels. In Mexico, chocomilk powder is fortified with iron. In Tanzania, a fortified orange beverage drink has been effective in improving iron and vitamin A status among school children. Apart from such programs with a limited target population, it is not expected that processed foods or beverages could serve as a mainstay for food fortification programs in developing countries. While fortifying foods that are not widely consumed by the population as part of the daily diet, it must be kept in mind that it is virtually impossible to ascertain the effect of any one product on iron balance in the population and difficult to regulate the level of iron supplied to the population.

Vitamin A

Several options are available for combating VAD, including distribution of capsules, nutrition education, and introduction of farming techniques to grow carotene-rich foods in home gardens. However, given the magnitude and severity of VAD in some parts of the world, programs that can have an immediate impact are needed, while simultaneously dealing with the long-term nature of the problem.

Recognizing this, several countries in Central America like Costa Rica, Guatemala, Panama, and Honduras passed laws in the 1970s stipulating that all sugar for home consumption had to be fortified. However, a combination of political and administrative constraints prevented this goal from

being realized, even though the technical feasibility of the process had been well established. Since the early 1990s, fortification programs have been renewed with full cooperation from the sugar industry. Recent impact studies among Guatemalan school children have shown a sharp reduction in VAD.

In India and Pakistan, it is mandatory for *vanaspati* to be fortified with vitamin A. India is also considering extension of this requirement to cover all edible oils. In the Philippines, vitamin A fortification of margarine is mandatory. Shelf-stable margarine containing 375 RE vitamin A per 15-g serving has been in the market since 1993. Studies showed that within 6 months of consumption there was a 6 percent decrease in low serum retinol. Monosodium glutamate (MSG), a widely consumed condiment of daily use in several southeast Asian countries, has been seriously considered as a vehicle for vitamin A but still faces problems of stability and the advisability of using MSG, whose long-term health effects are still unknown. In Tanzania and more recently in India, tea is being considered as a possible vehicle for vitamin A.

SELECTION OF FOOD VEHICLES

In many countries, a flexible approach utilizing a variety of vehicles, each fortified to a specified proportion of the recommended daily intake (RDI), may offer an effective option. If consumption of a particular vehicle is consistent in some groups but only sporadic in others, fortifying several vehicles provides complementary coverage. In the Philippines, a variety of vehicles including margarine, flour, noodles, and sugar will offer protection from micronutrient deficiencies for specific consumer segments. When considering a multifaceted approach, each food vehicle offers specific opportunities and constraints.

Staple cereals. Inexpensive staples like rice, corn, and wheat flour reach the broadest population. However, these foods are often eaten where they are grown and processed at the community level. This limits opportunities to ensure quality and safety.

Cooking media. Fats and oils may offer an option to meet a portion of the RDI. They are often centrally refined and packed.

Dairy Products. Milk may offer an option where centralized dairy processing exists. However cost, distribution, and other factors may limit accessibility among vulnerable populations.

Condiments. Sugar, spices, starches, and sauces are attractive carriers. Some are processed centrally and consumed in regular quantities.

Value-added products. These higher-priced products may be consumed only sporadically by the most vulnerable populations. However, consumer awareness, technical breakthroughs, and marketing innovations often emerge from the development of fortified value-added products.

When no universally consumed vehicle is available in a country, the fortification of a number of foods offers several key strategic advantages. When several food sectors are engaged, no single industry can resist on the grounds that it is being unfairly singled out. When various foods are fortified, each with a proportion of the RDI, the theoretical possibility of consuming dangerous levels of a micronutrient through excess consumption of a single food becomes remote.

COST AND FINANCING OF FORTIFICATION PROGRAMS

Table 1 shows the vitamins most commonly used for fortification and the corresponding annual cost per capita when supplementing the diet with one third of the RDA. The costs indicated are only approximate and indicate order of magnitude figures for actual processing and chemical cost at source only. They exclude program management and product promotion/marketing and monitoring costs. In most cases this additional cost is 5 to 10 percent of the micronutrient cost.

It often happens that the extra cost at source when passed on to the consumer, tends to get magnified at the various stages of distribution because the margins at every level will also increase proportionately. Therefore, the ultimate cost to the consumer will be progressively inflated as the food

passes through from producer to retailer. This is an economic issue that may need investigation on a case-to-case basis.

Table 1. Cost of Fortification

Vitamin			1/3 RDA Cost/Person/Year ($)
A (250 CWS)	1111	IU	0.073
D (100 CWS)	133	IU	0.016
E (50 % CWS)	5	IU	0.139
B1	0.47	mg	0.004
B2	0.57	mg	0.013
B6	0.73	mg	0.006
Niacin	6.3	mg	0.019
Folic Acid	66.7	mcg	0.001
B12	1	mcg	0.014
C	20	mg	0.055
Total			0.339

RECOMMENDATIONS FOR DEVELOPING A FOOD FORTIFICATION STRATEGY

Food fortification is an important component of the overall strategy to eliminate micronutrient malnutrition. A country's investment in an efficient program for food fortification can be very cost effective. In addition, the food industry and trade can develop systems to derive economic and social benefits for themselves while simultaneously providing a social benefit to the community by fortifying the foods they produce and sell. However, for food fortification to be effective and well coordinated, several issues need to be addressed.

1. Food fortification is a unique example where industry and trade, which work in a largely commercial environment, are required to participate and play a leading role in a health intervention endeavor. In order to have an effective and sustainable fortification program, it is vital that the public and private sectors should work in close collaboration, explicitly understanding and recognizing each other's viewpoints, concerns, and interests.

2. The fortification strategy should be linked with other intervention strategies like supplementation, dietary approaches, and nutrition education.

3. A detailed technical problem-solving exercise should be carried out to confirm that the fortification process is feasible and does not alter the vehicle in any way, while nutrient losses on storage and cooking are within tolerable limits. Industry could be involved in technology development, production, and quality control. Multinational companies with research and development facilities could be a source of technical expertise.

4. Technology development will have to be followed up with field and pilot commercial trials to evaluate the technical and economic feasibility and consumer acceptability of the product.

5. Food fortification programs should be planned to dovetail into existing food production and distribution systems within the country or region with minimum disruption and cost.

6. Food quality should be monitored through regulation and effectively enforced.

7. The importance of social communication cannot be overstressed. All available media should be used to educate the population on the issues of micronutrient deficiencies, and on the importance and safety of fortified foods. Consumers should be educated to demand a better product and accept a slightly higher price for that product.

8. Whatever the external input, nothing can succeed without an adequate nucleus of well-trained nationals. Specialized training is especially called for in the assessment, fortification, quality control, and monitoring and evaluation procedures.

9. As programs get under way, effective monitoring of process and outcome variables is critical. Measurement of food quality and fortificant levels in the foods at different levels from production to consumption is an essential step to ensure that adequate quantities of the nutrient are reaching the population. This must be combined with periodic estimation of clinical and biochemical indicators to evaluate the impact of the intervention. Programs should be envisioned as long lasting with evaluation as an essential component to identify progress, problems, and needs.

10. Intersectoral and international mechanisms of cooperation and coordination should be established for control of the distribution and marketing of fortified products.

Effective fortification requires active collaboration between several sectors: the scientific community, government, private industry, consumer groups, and international agencies, as outlined below.

The scientific community has identified the problems of micronutrient malnutrition and possible solutions through enrichment of a variety of foods. Over the past decade, considerable expertise has also been built up in the development of programs with in-built support measures like advocacy and social communication, legislation and enforcement, monitoring and evaluation, and training.

National governments must provide the administrative support and prescribe the framework within which solutions can be implemented and regulated.

The food industry has the technology, the capacity to mobilize resources, and the marketing capability to translate these needs into economically viable products that will be affordable and nutritious.

The consumer needs to be educated regarding the benefits and low cost of food fortification in order to create a "demand pull" to which industry would have to respond.

International and bilateral aid agencies could provide initial advocacy and seed technical/funding support for development of strategies and interventions.

CONCLUSION

The control of micronutrient deficiencies is a realizable goal, notwithstanding the magnitude of the task and the many challenges and constraints that remain to be resolved. Food fortification could be an important strategy to help realize this goal. Effective fortification requires active collaboration between several sectors: the scientific community, the government, private industry, consumer groups, and international agencies.

As the food and food processing industry in Asia expands, it will play an increasingly critical and complex role. Food fortification offers a unique opportunity for the industry to simultaneously expand its market and profitability while playing a key role in improving the physical, social, and economic well-being of Asian nations. ❐

Why Countries and Companies Should Invest to Eliminate Micronutrient Malnutrition

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Asian Development Bank

Food fortification is an essential element in national food policies in Asian and Pacific countries to ensure nutrition security for all their citizens. The precise role of fortification in relation to other strategies is addressed elsewhere in these proceedings. The focus here is on the rationale for investment in eliminating micronutrient malnutrition so that society's investment can enhance productivity, efficiency, and equity. It is an unusual thought to some—that galvanizing the private sector to raise the standard of affordable food quality can yield profit and also serve the public interest. But that is the compelling truth, based on the experience of the industrialized world.

MAGNITUDE OF THE PROBLEM

Thirty percent of the world's population is affected by vitamin A, iron, or iodine deficiency. Some 735 million persons suffer from clinical forms of these deficiencies and another two billion from subclinical forms. Collectively, they damage health; cause death; harm reproduction; reduce intelligence, educability, and academic achievement; and lower work productivity and occupational choices. Of special concern, micronutrient deficiencies interfere with child growth and development, sometimes permanently.

As if these losses were not devastating enough, there are insidious, rarely quantified costs that result from deficiency-caused disabilities. These include therapeutic health care; remedial education for the blind, retarded, and deaf; custodial care for cretins; limited occupational choices for the mentally retarded, blind, deaf, and anemic workers; and care for motherless children.

In Asia, vitamin A status has improved because of supplement programs for young children (about 80 percent coverage), but about one third of preschoolers and their mothers have subclinical VAD, which is responsible for many deaths and disabilities (such as blindness and night blindness).

Over the last decade, the proportion of Asian households consuming iodized salt has increased from about one fourth to two thirds, resulting in lowered goiter rates and improved intelligence in young children. That is excellent progress, but nearly one billion Asians remained uncovered by the USI. In areas where iodine deficiency is endemic, such as Central Asia, the average child loses 13 IQ points and this remains a grave concern for nearly one third of Asian families.

Iron deficiency anemia (IDA) affects 60 percent of Asian women of reproductive age, and 40-50 percent of preschoolers and primary graders. This causes more than half the maternal deaths in the world and depresses language and reading skills, hence academic achievement, of young students.

Three fourths of all persons suffering from micronutrient deficiencies live in the region. The road to regional health and life-long productivity cannot be passed without removing the obstacle of micronutrient malnutrition.

WHY INVEST?

The Public-sector View

Human capital improvement is an essential goal of economic development, and nutrition is an important feature in human capital. The consequences of malnutrition are serious in both the short and long term: current health and productive activities are harmed, and the potential of future generations will be damaged.

All the governments in the region endorsed the commitment expressed at the World Summit

for Children that several forms of micronutrient malnutrition should be eliminated by 2000; yet the reality is far from that goal. Partnership with the private sector offers the possibility of achieving the goal by 2010. Governments are also committed to reducing child and maternal mortality (at the International Conference on Population and Development), to investing efficiently in primary health care and public education, and to enhancing educability and productivity. Yet there is a clear association between prevalence of malnutrition and prevalence of morbidity for infectious diseases (poor nutrition weakens immunity), as well as the percentage of dropouts from primary school throughout the region. Malnutrition lowers the effectiveness of public expenditure on children. Lastly, the public sector should reduce malnutrition early in life to reduce chronic adult disease, support safe motherhood, and sustain economic growth through human capital improvement.

The Industry View

The private food industry has equally compelling reasons for shifting production to fortified foods if they are profitable. Raising product quality through fortification will stimulate demand for regional products, and intensify competition and trade with and beyond the region. Economies of scale for fortified foods, as competitors follow product leaders, will lower prices and enable new consumers to be reached.

Targeting fortified foods to poor women and children will improve the physical and mental development of future generations. Overcoming chronic undernutrition among the poor will raise education and wage levels, and consumer spending.

Equitable access and demand creation will put pressure on the marketplace. Informed consumers will be heard and the market will adjust.

Social marketing for fortified foods should be a shared public-private responsibility. Giving back to the community always enhances the image of the business community as partners in development.

THE ECONOMIC COSTS OF THE STATUS QUO

Mortality

A reexamination of underweight malnutrition on mortality of children less than five-years old showed that about 54 percent of deaths are associated with moderate and severe malnutrition, with the "moderates" responsible for most of the deaths (Pelletier, 1994). While malnutrition is associated with being underweight and mortality risk is linked to the severity of that state, recent evidence shows that micronutrient deficiencies play a major role in mortality risk as well, especially for pregnant mothers and young children, through influence on height, size, and proper functioning of the immune system. Child deaths from infectious disease are strongly influenced by micronutrient status. VAD in both the clinical and subclinical forms is a major risk factor for children dying from measles, pneumonia, and diarrhea. Studies have shown that improving the vitamin A status of children less than five-years old and their mothers during pregnancy and lactation will reduce mortality by about one fourth, possibly more.

A recent study (ADB-UNICEF, 1999) concluded that in nine low-income Asian countries[3], moderate and severe malnutrition is responsible for 2.8 million preventable child deaths annually. In addition, there are 65,000 maternal deaths annually from anemia (Table 1).

There are also substantial deaths of mothers and preschoolers from subclinical VAD. It was recently estimated that the lives of some 714,000 children less than five-years old have been saved annually in 12 low- to middle-income Asian and Pacific countries from steady improvement of vitamin A status, with an additional 211,000 instances of child blindness avoided (Table 2). The human tragedy that these figures represent dwarfs the economic consequences, but the lost potential of these lives is a very high price to pay for inaction.

[3] Bangladesh, Cambodia, People's Republic of China, India, Lao PDR, Nepal, Pakistan, Sri Lanka, and Viet Nam (Horton, 1999).

Table 1: Estimates of Excess Mortality Attributable to Malnutrition

Country	Child Deaths		Maternal Deaths	
	Per Year ('000)	No. Due to Mod/Severe Malnutrition ('000)	Per Year ('000)	No. Due to Anemia ('000)
Bangladesh	327	215	24.3	5.6
Cambodia	63	39	33.0	7.6
PRC	970	287	19.6	4.5
India	2,810	1,730	139.3	32.0
Lao PDR	30	17	1.5	0.3
Nepal	95	51	12.5	2.9
Pakistan	687	367	17.1	3.9
Sri Lanka	6	3	4.0	0.9
Viet Nam	92	53	33.0	7.6
Total	5,080	2,762	284.3	65.3

Source: Horton (1999).

Author's calculations, using data in Table 1, Appendix Table 1, and information on relative risks in Pelletier et al. (1994) and Ross and Thomas (1996).

Table 2: Improving Vitamin A Status in Asia: Saving Lives, Eyesight, and Health Care Costs

Country	Children's Lives Saved Per Year ('000)	Childhood Blindness Averted Per Year ('000)	Savings in Health Care Costs Per Year	
			High	Low
			US$ ('000)	
Bangladesh	114.2	9.4	9,005	6,670
Cambodia	6.4	1.1	736	545
PRC	69.9	71.0	20,058	14,857
India	381.8	77.9	70,549	52,259
Indonesia	47.0	15.3	2,898	2,147
Nepal	12.1	2.5	1,978	1,465
Pakistan	66.1	15.9	10,139	7,511
Papua New Guinea	1.5	0.4	263	195
Philippines	5.0	6.7	3,408	2,525
Sri Lanka	0.4	1.1	741	549
Thailand	2.7	3.4	1,552	1,150
Viet Nam	7.3	6.7	5,119	3,792

Source: OMNI/USAID (1998).

While nutritionists tend to classify nutritional deficiencies as "macro" when they relate to inadequate energy and protein, and "micro" when referring to essential vitamin and mineral deficiencies, this is a confusing and false distinction. Both "macro" and "micro" deficiencies influence height, size, immunity, and brain development. And dietary deficiencies are responsible for both kinds of problems. Thus, the food industry should understand its unique opportunity to solve both nutrition problems through food vehicles properly tailored to different consumer audiences. This amounts to a "dietary quality" revolution as profound as the green revolution of the 1960s. The issue is no longer simply food security based on per capita calorie availability. Rather, it is comprehensive nutrition security based on an affordable diet of high nutritional quality whose outcome is better judged by mental acuity and economic productivity than by mere physical survival.

Productivity

The direct productivity effects of malnutrition are on the capacity to perform physical work and on earning ability. Protein-energy malnutrition (PEM), stunting, and iron-deficiency anemia (IDA) reduce both. Improvements in PEM improve wages through increases in weight-for-height, while improvements in iron increase the capacity to perform moderate to hard labor with related increases in wages. These effects have been demonstrated in India, Indonesia, Philippines, and other countries (Haddad and Bouis, 1991; Basta et al., 1979; Deolalikar, 1988; Spurr et al., 1977; consolidated in Behrman, 1992).

The indirect productivity effects are on cognitive ability and achievement, through impact on psychomotor skills, development quotients (DQs) for infants, and intelligence quotients for both

preschool and school-age children. IDD, PEM, and IDA have substantial negative impact on developmental capacities of children, probably in that order of significance. In high-risk populations with a large incidence of goiter, IDD depresses average intelligence by 13 IQ points (Bleichrodt, 1991). Salt iodization programs throughout Asia are rapidly eliminating this problem, but much work remains to be done in terms of program coverage and product quality. IDA depresses psychomotor skills and intelligence, but the effects are reversible if the intervention is early enough (Brown and Pollitt, 1996; United Nations Subcommittee on Nutrition, 1991). PEM depresses DQs, and Bayley scores in 12-month-old children in a controlled study have shown that psychomotor and mental development indices correlate with birth weight groups. However, appropriate complementary feeding for under-twos has a remarkable effect on stunted children of impoverished background, especially when combined with early cognitive stimulation (Grantham-McGregor, 1995).

Further evidence suggests that thin children are usually the issue of thin mothers, and both are caught up in an intergenerational cycle of poverty and malnutrition. Underweight or very thin children, suffering from macro- and micro-deficiencies, are much more susceptible to chronic diseases in midlife, including cardiovascular diseases, hypertension, and diabetes, which combined with poor adult diets predispose for adult obesity (Barker, 1996). Thus, poor children risk a "double burden of disease" through fetal risks. Proper nutrition for the mother and young infant will avert a substantial disease burden across the life cycle of the next generation.

Macroeconomic Impact: Depression of Growth

A recent effort to impress governments on the urgency of taking action has yielded estimates of the growth-reducing impact of malnutrition in a number of low-income Asian nations. ADB and UNICEF worked with seven countries[4] to develop 10-year investment programs that would achieve the International Conference on Nutrition and World Summit for Children goals somewhat belatedly. The general conclusion was that malnutrition, with its insidious effects over the life span of the child, will cost the economy at least 3 percent of gross domestic product, based on conservative assumptions (a "low scenario" built into the model). India, for example, loses growth from two directions: adult productivity (3 percent) from PEM, iodine deficiency, and iron deficiency; and from IDA-induced cognitive impairment (about 1 percent) (Table 3). The study estimated that productivity losses for manual laborers are up to 9 percent for severely stunted workers; losses from IDA are 17 percent for workers engaged in heavy physical labor and 5 percent for moderate workers. Losses due to cognitive deficits for malnourished children were 10 percent for stunted individuals, 4 percent for IDA, and 10 percent for IDD (Horton, 1999). This translates into a staggering sequence of losses in growth and human potential for the region as a whole.

Table 3: Estimates of Productivity Costs of Malnutrition in Selected Countries, as Percentage of GDP

Losses of adult productivity

Country	PEM	Iodine Deficiency	Iron Deficiency
India	1.4	0.3	1.25
Pakistan	0.15	3.3	0.6
Viet Nam	0.3	1.0	1.1

Losses including childhood cognitive impairment associated with iron deficiency

Country	Cognitive Only	Cognitive Plus Loss in Manual Work
Bangladesh	1.1	1.9
India	0.8	0.9
Pakistan	1.1	1.3

Sources: Calculations for adult productivity from AERC (1998), Administrative Staff College (1998), and Horton (1999), including impairments from Ross and Horton (1998). The data for India from Administrative Staff College are the "low scenario" and are about half the size of the "moderate scenario" losses, and only one third the size of the "high scenario" losses.

[4] Bangladesh, Cambodia, People's Republic of China, India, Pakistan, Sri Lanka, and Viet Nam.

COSTS AND BENEFITS OF SUSTAINED NUTRITIONAL IMPROVEMENT

Cost Effectiveness

Cost-effective nutrition interventions are available and should be used more consistently (World Bank, 1993; Del Rosso and Marek, 1996; Horton, 1999; Institute of Medicine, 1998). Expressed in terms of disability-adjusted life years (DALYs), or healthy years of life saved, the following interventions cost less than $25/DALY: breastfeeding promotion, salt iodization, staple fortification with vitamin A, semi-annual mass doses of vitamin A, iodine injections for pregnant women, and daily (probably weekly also) oral iron for pregnant women; other interventions available for under $75/DALY are: improved weaning practices for children, and food supplements for children and pregnant women. The Institute of Medicine (1998) summarized evidence on iron and vitamin A interventions, both supplementation and fortification; most interventions cost less than $25/DALY[5] (Tables 4 and 5), as do some school health and nutrition programs that are competitive with immunization programs (Table 6, from Del Rosso and Marek, 1996).

Returns on Nutrition Investments

The World Bank (1994) summarized the benefits of micronutrients in terms of cost per life saved and productivity gained per program (Table 7). For saving lives at least cost, targeted supplementation to at-risk groups (pregnant mothers for iron, under-fives for vitamin A) is more cost effective than fortification, although the latter is a more sustainable solution in the long run as incomes rise and households gain access to higher-quality primary health care. Nevertheless, properly targeted supplementation is justified while fortification programs are in the early stage and expanding coverage, as long as the targeting principles reflect risk assessment and are consistently applied.

From the perspective of enhanced productivity delivered by programs, where productivity is defined as the least-cost method of reducing clinical deficiency in the population, fortification is clearly the public policy choice. Fortification is

Table 4: Cost and Benefit/Cost Ratios of Iron Supplementation Schemes and General Iron Fortification Programs

Intervention	Benefit/Cost Intervention	No. DALYs[a] Achieved	Cost Per DALY (US$)
Short-term (daily, weekly) benefits and costs of iron-supplementation programs			
Prenatal supplementation only	511	100	51
Widespread supplementation to all iron-deficient and anemic subjects and at-risk groups			
Universal fortification	5,038	16	11
plus residual prenatal supplement[b]	5,394	39	16
Long-term benefits and costs of iron- supplementation programs			
Preventive supplementation	2,679	37	17
Fortification	3,332	9	

DALY = disability-adjusted life year.

[a] Per 100,000 population, considering global birth rates, fixed and other operational costs, and current individual expenditures in purchasing iron-containing preparations (based on information from Guatemala).

[b] Considering that in spite of iron fortification and adequate prepregnancy iron reserves, prophylactic iron supplementation will still be recommended during pregnancy.

Source: Institute of Medicine (1998).

Table 5: Cost-effectiveness of Some Vitamin A Interventions

Intervention	Target Groups	Approximate Cost (US$) Per Death Averted	Per DALY Saved
Supplementation	Children < 5 years	50	1
Fortification	Entire population	154	4
Food supplement	Children < 5 years	1,942	63
Food supplement	Pregnant women	733	24

DALY = disability-adjusted life year.

Source: Adapted from World Bank (1993, p. 82).

[5] Prenatal iron supplementation and vitamin A-enriched food supplements are higher but within the $75/DALY group.

Table 6: The Cost-effectiveness of School-based Nutrition and Health Services

Health Intervention	Cost Per DALY Gained (1990 US$)
EPI Plus	12-30
School nutrition and health programs	20-34
Family planning services	20-150
Integrated management of the sick child	30-100
Prenatal and delivery care	30-100
Tobacco and alcohol prevention programs	35-55

DALY = disability-adjusted life year; EPI = Expanded Programme on Immunization.

Source: Del Rosso and Marek (1996).

(e.g. breastfeeding) under $5; and community-based programs (growth monitoring, home gardening), less than $10. The outlier is feeding programs, which range from $70 to $100, suggesting that the long-standing practice of untargeted or inappropriately targeted food subsidies in large parts of Asia has been expensive and inefficient by international standards. Reallocation of those resources to more cost-effective nutrition outcomes should be the priority of governments before they seek external assistance.

Table 7: Returns on Nutrition Investments

Deficiency/Remedy	Cost Per Life Saved (US$)	Discounted Value of productivity Gained per Program (US$)	Cost Per DALY gained (US$)
Iron deficiency			
Supplementation of pregnant women only	800	25	13
Fortification	2,000	84	4
Iodine deficiency			
Supplementation (reproductive-aged women only)	1,250	14	19
Supplementation (all people under 60)	4,650	6	37
Fortification	1,000	28	8
Vitamin A deficiency			
Supplementation (under-5s only)	325	22	9
Fortification	1,000	7	29
Nutrition education[a]	238		
Nutrition education and maternal literacy[a]	252		

DALY = disability-adjusted life year.

[a] Tilden et al. (1994).

Source: World Bank, Enriching Lives (1994).

three times as productive as supplementation with vitamin A for under-fives or iron supplementation for pregnant women, and is four times as productive as general iodine supplementation and twice as productive as targeted supplementation for reproductive-age women. So the population-wide impact is greatly increased by fortification.

Based on the ADB-UNICEF seven-country study, the calculated costs per beneficiary per year, per 1,000 calories delivered (Table 8) were in the following order: all micronutrient supplementation and fortification programs, less than $1-except iron for pregnancy, less than $2; nutrition education

An Investment Bargain

Investment per head in fortifying staple and weaning foods is an order of magnitude lower than highly cost-effective supplementation programs. For example, iodine supplementation per capita for at-risk groups costs $0.50 per year, while fortification costs only $0.05 per capita per year. The cost of adding fortificants for essential vitamins and minerals is about $0.40 per person annually[6], about

[6] This assumes total iodine and iron requirement and about one third of the RDA for vitamins A, D, E, and the B group.

Table 8: Approximate Unit Costs of Interventions with Effects on Nutrition

Intervention	Cost Per Beneficiary Per Year (US$)
Education (e.g. breastfeeding)	5.00
Micronutrient supplementation	
– iodine	0.50
– iron (per pregnancy)	1.70
– vitamin A	0.20
Micronutrient fortification	
– iodine	0.05
– iron	0.09
– vitamin A	0.05–0.15
Feeding programs	70.00–100.00
Community-based programs (home gardening, growth monitoring)	5.00–10.00

Source: Horton (1999).

the cost of a packet of cigarettes. Put another way, the additive costs of fortificants are no more than 3 percent of the $12 per person that WHO recommends countries spend on primary health care. Since micronutrient enrichment is as effective in preventing illness, disability, and death as is primary health care, there will be no sensible argument against fortification as long as the public is aware of the benefits.

Both producers and consumers need to be fully informed about the minimal change in production or purchasing decisions required to shift preferences and demand to fortified foods. The technical costs of production are not prohibitive.

The public sector has a major role to ensure quality assurance and a level playing field for all producers, and to assist the shift to fortified staples with aggressive social marketing to the less affluent. This is a proper use of public resources because it has a preventive health thrust and will allow people's needs to be both felt and informed. The result will be informed choices by all groups of society.

A major regional effort to shift public resources toward public-private partnership to promote fortification of staples and complementary foods for infants is needed, and this deserves extensive discussion.

Our task is to disseminate to policymakers information about what the status quo costs in lives, disabilities, and lost resources, and how beneficial fortification approaches could be applied. The donor and professional communities should then provide concerted support.

Optimum Benefits Obtained by Targeting Complementary Foods to Children Less Than Two-years Old

No one at this distinguished conference would see nutrition as an isolated intervention, since the pivotal issue is how investments can produce better students and more productive citizens. Child nutrition is an essential element in human development, and is best improved in the context of coordinated investments in primary health care, and early and basic education. There are synergistic benefits:

- nutrition has an impact on health through immuno-competence and stronger resistance to life-threatening infection;
- health has an impact on nutrition in that reduced illness leads to weight and height gain;
- nutrition and health improve psychosocial development and learning through better psychomotor skills and socialized vitality; and
- nourished children who attend preschool are better socialized as preschoolers, less likely to drop out of primary school, adjust better to the social and academic environment of school, and perform better, especially in the early grades.

Two longitudinal studies in the INCAP villages in Guatemala (20 years) and Cebu, Philippines (15 years), respectively, provide strong evidence that the consequences of early childhood stunting are lower IQs, achievement scores, school attainments as teenagers, adult literacy, and wages. There are also behavioral effects such as poor attention and school performance, and poor interaction with adults. Conversely, early complementary feeding (with balanced macro- and micronutrients) for undernourished children less than two-years old (for about a year)

has long-lasting benefits that reverse the intergenerational cycle of growth failure to a positive outcome and a hopeful future for poor children (Brown and Pollitt, 1996; UNICEF, 1998). The INCAP study showed that better nutrition improves IQs, achievement scores, adolescent intellectual performance, adult literacy, and wage effects.

Important as these findings are, the potential of the food industry to create nutritious foods for young infants has yet to be tapped in the region. For the food industry in Asia and the Pacific, complementary food vehicles are at the cutting edge of product development and social marketing strategy, especially for the lower-income groups. However, the purpose of this Forum is to identify key areas for rapid development at the regional level. There is compelling evidence, in part drawn from the financial and economic crisis in Asia, that countries risk a "lost generation" unless they improve nutrition for children less than two-years old, the stage of life when the body and brain experience maximum growth potential. The importance of adequate iron, vitamin A, and iodine during this period, combined with continued breastfeeding beyond the first six months, cannot be overestimated for the child's prospects as a student, as a worker, and as a citizen.

Let us "push the envelope" in the region and see how the food industry can assist parents in improving the cognitive potential of the current and future generations of children. From the food technology perspective, the challenge is to increase the energy density of complementary foods with multiple fortification of essential vitamins and minerals at an affordable price. From the public health perspective, proper regulation that protects infant health yet supports industrial innovation is needed, combined with strong public education on appropriate infant feeding practices and psychosocial care of the infant. No initiative by ADB or the private sector could more profoundly reduce poverty than to render the newborn pliant for life-long learning through adequate nutrition and care. The private sector has a major opportunity to influence the future of children here as well as gain generations of grateful customers.

Summary: Economic Benefits of Fortification Programs

As adapted from Popkin (1998), in Figure 1, the economic benefits of fortification are reduced morbidity, improved work capacity, and improved cognitive effects.

Outcome	Benefits	Value
Reduced morbidity	Reduction in health care (depending on patterns of care)	Expenditure on health care, associated travel, and drugs
	Reduction in days of work lost by sufferer or carer (depending on employment status)	Improved marginal productivity of labor
	Improvement in school attendance, concentration, and performance	Reduction in wasted education expenditure
	Production and consumption benefits	Discounted present value of per capita income over the years of life lost from premature death
Increased physical work capacity	Increased work output	Improved marginal productivity of labor
Improved cognitive effects	Greater efficiency of school system; increased future productivity	Reduction in wasted education expenditure; reduced school dropout and retention rates
		Relationship with earnings and marginal productivity of labor

Figure 1: Valuation of Economic Benefits of Fortification Programs

Reduced morbidity will reduce health care costs and days lost in school or at work; improve school attendance, concentration, and performance; and strengthen both production and consumption benefits. Reduced public health and public education expenditure, and reduced school dropout and retention rates will increase efficiency of public investment for essential social services and free resources for better uses.

Economic value of fortification is expressed in improved work output due to increased workcapacity and improved marginal productivity of labor.

Lastly, improved cognitive ability will allow realization of the benefits of education expenditure; raise the number of years of schooling and academic performance; and, in a growing economy, will also raise wages and household income invested in the quality of the next generation of children.

CONCLUSION

It seems to this observer that the timing is right to bring the technical specialists, business strategists, and investment planners into a common arena, and take concerted action for the region, especially for its children. No one is suggesting that food fortification is a magic bullet, but it offers a long-term, effective, and sustainable solution to eliminate the problem within an integrated strategy that includes supplementation, dietary change, and diversified household and homestead production.

Having said that, food fortification is one of the great investment bargains of the decade, and offers the most assured, least-cost strategy to correct iodine, vitamin A, and iron deficiencies. It could improve the population-wide IQ by 10-15 points, reduce maternal deaths by one third, decrease infant and child mortality by 40 percent, and increase work capacity by almost half. ❐

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