Micronutrient malnutrition is a major global public health problem affecting more than a third of the world population. Consequences of this malnutrition are widespread and severe. It has been estimated that iron deficiency impairs the mental development of 40 to 60% of children in developing countries, vitamin A deficiency affects 40% of children <5 y of age in the developing world and is a factor in >1 million child deaths per year, and iodine deficiency during pregnancy causes mental impairment in 18 million babies born every year (1).

Several strategies have been proposed to address the problem. They include food fortification, dietary diversification, dietary supplementation, nutrition education, and public health measures to control intestinal parasites and other infectious diseases. Although significant reductions in the high prevalences of micronutrient malnutrition will require multiple, complementary approaches, food fortification, the focus of this symposium, is arguably the most cost-effective and practically feasible strategy over the near term.

Fortification has been a major strategy aimed at improving the nutritional quality of the food supply in industrialized countries for many decades but has only recently been applied in many developing countries. Several conditions are necessary for a successful national food fortification program. These include nutritional surveillance procedures to assess the prevalence of malnutrition and the shortfall of individual nutrients in the food supply; a suitable food vehicle that is widely consumed, especially by population groups most at risk for deficiency; centralized food-processing infrastructure, and technical expertise to ensure uniform addition of the nutrients to the food at low costs; availability of fortificants in forms that are stable to storage and cooking and that do not cause changes in the appearance or flavor of the food; suitable government oversight and quality control procedures to monitor addition to the food vehicle; an education program to inform people of the benefits of consuming fortified foods; and continued nutrition-monitoring programs to assess the impact of fortification and to guard against excessive intakes of nutrients. A recent WHO publication titled “Guidelines on Food Fortification with Micronutrients for the Control of Micronutrient Malnutrition” (2) provides a comprehensive overview of food fortification in developing countries.

Although many if not all of the above conditions are in place in most industrialized nations, many less-developed countries lack the resources to meet them, creating difficult challenges for implementing successful fortification programs. This symposium addressed some of these challenges and offered some solutions. The authors represent a variety of academic disciplines, demonstrating the breadth of expertise needed to understand the limitations to food fortification as it applies to developing countries and the novel approaches needed to overcome technical, nutritional, social, and economic challenges in these resource-limiting settings.

Lindsay Allen, a nutrition scientist, reviews the basic elements of successful food fortification programs, pointing out constraints to their implementation in less-developed countries. She suggests a series of formative research procedures that should be considered by nutrition scientists to improve program success.

Haile Mehansho, a food scientist, describes a new technology for adding iron to foods that prevents the adverse changes in appearance, taste, and stability that often occur. With this technology, iron is stabilized using a combination of encapsulation, chelation, and redox modulation. The bioavailability of the stabilized iron added to a powdered fruit beverage was comparable to that of ferrous sulfate.

Penelope Nestel and her co-authors, who represent the diverse disciplines of nutrition, economics, and plant breeding, describe a promising new approach called biofortification. With this strategy, staple food crops such as rice, wheat, maize, and sweet potatoes are enriched with selected micronutrients through plant breeding. The nutritionally enhanced seeds are then distributed to farmers who plant them and harvest crops with increased micronutrient density. The authors conclude that biofortification is technically feasible and that the nutritionally enhanced foods can help to control micronutrient deficiencies.

Susan Horton, an economist, reviews some of the literature on cost-effectiveness and cost-benefit of food fortification strategies as they apply to developing countries. She reports that fortification of selected nutrients has been shown to have a
significant impact on reducing child mortality, improving cognitive development, and raising economic status. Horton concludes that the relatively low unit costs of food fortification along with the proven benefits to the quality of life of the poor in developing countries contribute to large benefit-to-cost ratios and justify the investments.

In summary, the papers from this symposium provide evidence that food fortification is one important tool for improving nutritional status in developing countries. Constraints such as adverse changes in sensory characteristics in the fortified foods and a lack of food-processing facilities for adding nutrients can be overcome by controlling the chemical reactivity of nutrients or using biofortification. Among the several proven approaches available for addressing the problem of micronutrient malnutrition, fortification is currently the most cost-effective and sustainable. However, the magnitude of the problem requires a combination of strategies, of which fortification is only one.

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