



---

The History of Food Fortification in the United States: Its Relevance for Current Fortification Efforts in Developing Countries

Author(s): David Bishai and Ritu Nalubola

Source: *Economic Development and Cultural Change*, Vol. 51, No. 1 (October 2002), pp. 37-53

Published by: [The University of Chicago Press](#)

Stable URL: <http://www.jstor.org/stable/10.1086/345361>

Accessed: 29/03/2013 10:33

---

Your use of the JSTOR archive indicates your acceptance of the Terms & Conditions of Use, available at <http://www.jstor.org/page/info/about/policies/terms.jsp>

JSTOR is a not-for-profit service that helps scholars, researchers, and students discover, use, and build upon a wide range of content in a trusted digital archive. We use information technology and tools to increase productivity and facilitate new forms of scholarship. For more information about JSTOR, please contact support@jstor.org.



The University of Chicago Press is collaborating with JSTOR to digitize, preserve and extend access to *Economic Development and Cultural Change*.

<http://www.jstor.org>

# The History of Food Fortification in the United States: Its Relevance for Current Fortification Efforts in Developing Countries\*

David Bishai  
*Johns Hopkins Bloomberg School of Public Health*

Ritu Nalubola  
*MOST, the USAID Micronutrient Program*

## **I. Introduction**

Food fortification stands out among public health interventions as one of the most effective methods of preventing nutritional deficiencies. Food fortification in the United States has contributed significantly to the virtual eradication of goiter, rickets, beriberi, and pellagra.

The efforts of food fortification planners are routinely challenged by a variety of political, social, and technical obstacles.<sup>1</sup> Consequently, public health scientists and policy makers have developed guidelines to assist in the design, implementation, and evaluation of food fortification programs.<sup>2</sup> However, there is little in the published literature that documents and synthesizes the long U.S. experience with food fortification into an organized history.<sup>3</sup> This essay is an attempt to examine the American experiences with food fortification in the context of current food fortification efforts in developing countries. We also attempt to describe the past roles of the food industry, the government, and the professional health organizations in U.S. food fortification programs.

This article examines the several major waves of food fortification in the United States: iodization of salt in the 1920s, fortification of milk with vitamin D in the 1930s, enrichment of flour and bread in the 1940s, and the widespread addition of calcium to a variety of products beginning in the 1980s. Throughout the article our focus will be on the social, economic, and political aspects of food fortification, rather than on technical issues. This article does not review fortification experiences globally. The experiences of other developed countries are likely to be different from those in the United States and may

© 2002 by The University of Chicago. All rights reserved.  
0013-0079/2003/5101-0002\$10.00

offer more or different lessons than what is summarized here, which is based on the U.S. experience.

In each of these cases, special attention is paid to the role of the food industry. One of the features that distinguishes food fortification from many other public health initiatives is the high level of involvement and motivation required of the private food industry. A strong interaction and cooperation is needed between the private and public sectors. It cannot be denied that part of the industry's motivation was increased profit and the protection of their products from competition. Nevertheless, it is not hard to find expressions of corporate public-spiritedness and concern for the well-being of the American consumer in the historical record. This is not to undermine the leadership role played by the government's advocacy and legislative efforts, especially in cereal enrichment, or the strong influence of the professional health organizations. Whatever the motivation, those involved in the early steps toward food fortification took pains to create a positive cultural meaning for food fortification to increase public understanding and ease implementation.

## **II. Adding Iodine to Salt**

In 1920, when David Marine and O. P. Kimball first announced that iodine could prevent endemic goiter in Akron schoolchildren, there were no precedents for the widespread addition of nutrients to food. When Marine and Kimball presented their findings to the Section on Pharmacology and Therapeutics at the American Medical Association (AMA) convention in June of 1921, they proposed the administration of iodine to patients directly, instead of via the food supply. They wrote, "Goiter in the mother and fetus can be prevented as simply as that of adolescence, but practically it would seem that it is a responsibility of individual physicians, supplemented by public education. The prevention of goiter of childhood and adolescence should be a public health measure, best administered through the schools in order to combine the important additional factor of education."<sup>4</sup> Marine, having conducted several animal studies with iodized salt, suggested that an iodized salt be used to prevent goiter in livestock.<sup>5</sup> Marine's goiter prevention plan followed the lines of his research protocol: droplets for children, salt for animals.

The news that iodine could prevent goiter made its greatest impression in the American Midwest where natural sources of iodine were scarce and goiter was endemic.<sup>6</sup> Just a few months after the publication of Marine and Kimball's article,<sup>7</sup> Harry Sloan, a Cleveland physician, modified Marine's suggestion for animals and proposed the use of iodized salt for human beings.<sup>8</sup> In 1922, David Cowie, a pediatrician at the University of Michigan, persuaded the Michigan State Medical Society to set up an Iodized Salt Committee with the express purpose of bringing about the iodization of salt.<sup>9</sup>

The Michigan State Medical Society launched one of the world's first food fortification campaigns with a degree of planning seldom seen in later ones. The documented success that attended these efforts made the Michigan experience with iodized salt one of the most noteworthy food fortification

programs in applied public health in the twentieth century.<sup>10</sup> After reviewing technical data on annual salt consumption, iodine toxicity, and the taste of iodized salt, the Michigan State Medical Society held several conferences with the Michigan Salt Producers Association. The society hired experts to work out the technology for large-scale manufacture and to investigate the salt industry's concerns. According to the society, some members of the salt industry were impressed by the potential to render a public service and cooperated in every way.<sup>11</sup> Others were not so enthusiastic. The Morton Salt Company's treasurer offered the following response to the medical society's suggestion: "It would seem to me that furnishing a salt with a certain content of iodine for use in any particular state would be rather a difficult problem for the salt manufacturers and that should more properly belong to the large pharmaceutical companies. As nearly as we can estimate, only about 15% to 20% of our product is used for domestic purposes, and I fear it would be an impossible task for us to separate that proportion from our general manufacture, more particularly, when it complied with the manufacture of one or two states."<sup>12</sup>

Understandably, the medical society did not rely exclusively on goodwill to achieve the salt industry's cooperation. In 1923, the society began to plan legislation to mandate the production of foods that would protect state citizens from goiter.<sup>13</sup> Salt makers feared that unless they iodized their product, they would be forced to produce only unrefined salt. Although unrefined salt contained iodine, it was not aesthetically pleasing.<sup>14</sup>

To help create a market for iodized salt, the society then organized an educational campaign with the help of the University of Michigan, the advertising departments of the salt companies, the salt retailers, and the press. The education committee prepared a lecture outline with a set of lantern slides about goiter, iodine, and salt and compiled a list of 170 physicians in the state who were recruited to deliver public lectures.<sup>15</sup> Schoolteachers were also provided with an educational program to use in the classroom. In May 1924, iodized salt was on the market, and the propaganda program was in full operation.

The public health workers had the foresight to conduct an epidemiological evaluation of this activity. The State Department of Health had conducted a baseline survey of the incidence of goiter in four counties. A later survey funded by the salt industry showed that, relative to the baseline, there was a 74%–90% decrease in goiter incidence between 1924 and 1935 in the four counties surveyed. It also showed a decrease in goiter incidence even among children who reported that they did not use iodized salt.<sup>16</sup>

The three key factors that made Michigan's program a success were (1) cooperation between the state public health workers and the salt industry at the planning stage, (2) a public education campaign preceding and overlapping with the actual introduction of the food, and (3) the epidemiological evaluation of the fortification program that provided evidence of the success of the program.

Between 1924 and 1928 the use of iodized salt spread rapidly throughout the country. From a business standpoint, it made sense for the individual salt manufacturers to keep up with what was perceived as a growing trend. By producing iodized salt, they were assured of not falling behind the competition and could advertise a new and improved product. The iodization cost only a fraction of a cent per box of salt. This added cost could be absorbed by the firm as a small investment in the maintenance of market share.

The salt industry participated heavily in publicizing the health benefits of iodized salt. A salt advertisement in the February 1926 issue of *Hygeia*, whose caption read "What Well-Known Medical Men Say," included the following quotes: "Iodine is almost an absolute preventive of goiter. That has been proved beyond all question. Given in table salt it is a preventive for goiter.—Dr. Charles Mayo, in an address before the Wayne County Medical Association, 26 January 1924"; "Iodine is not a medicine. It is simply a replacement of one of the needed elements in food. We urgently ask the people of our city to use iodized salt both for table and cooking.—Dr. S. C. Slemmons, City Health Commissioner, Grand Rapids, Mich." This advertisement provides an example of how public health workers insisted on a positive cultural meaning of fortification to enhance its acceptance and stressed that iodine is a food and not a medicine.

Very little legislation accompanied the introduction of iodized salt. In May 1924, at the behest of the medical society, Michigan enacted legislation requiring all salt sold in the state to contain 0.02% sodium iodide. No federal legislation requiring iodization of salt was ever passed, and, with the exception of Michigan, few states found it necessary to actively involve themselves in the matter. Furthermore, in contrast to the political furor surrounding iodization of the Rochester water supply, the iodization of salt went smoothly.<sup>17</sup> The reasons may be that, first, in most states consumers could still choose uniodized salt if they wished to; second, iodization of salt was carefully portrayed as restoring to salt what had previously been taken away. In the case of iodized salt, as with other foods, the federal government has generally been careful not to interfere with individual free choice. Currently, the only legal incentive the U.S. salt producers have to iodize salt is a 1972 ruling that requires iodized salt to be labeled "This salt supplies iodide, a necessary nutrient" and uniodized salt to be labeled "This salt does not supply iodide, a necessary nutrient."<sup>18</sup> Today, both iodized and uniodized salts are available to consumers at the same retail price.

### **III. Adding Vitamin D to Milk**

Unlike iodine fortification, where the deficient nutrient had been previously characterized, attempts to fortify milk with vitamin D occurred even before vitamin D had been purified and synthesized. Six years after Edward Mellanby's 1919 discovery of the efficacy of cod-liver oil in preventing rickets in puppies, S. J. Cowell found that irradiated milk was much more effective

than untreated milk in stimulating bone calcification in children.<sup>19</sup> (Irradiation of milk converts inactive ergosterol into physiologically active vitamin D<sub>2</sub>.) Cowell's discovery prompted Harry Steenbock's 1929 invention of a milk irradiator for industrial use. The well-known Wisconsin Alumni Research Foundation (WARF, as in the anticoagulant drug "warfarin") was founded in 1929 to administer the patent for the milk irradiator. Three years later, in 1932, vitamin D was purified and isolated. Thus, from 1919 until the late 1930s, a variety of milk products, cod-liver preparations, and combinations became commercially available for the prevention of rickets. After the original cod-liver oil came milk with cod-liver oil added, followed by irradiated milk, and milk from yeast-fed cattle. By 1932, milk began to be fortified with viosterol, a purified vitamin D product.<sup>20</sup> During this period even cereal manufacturers were interested in vitamin D research, expressing an interest in treating their product to the extent that it would not be in a commercially vulnerable position.<sup>21</sup>

The introduction of vitamin D–fortified milk into the marketplace appears to have taken a course similar to that of most new pharmaceuticals and other innovations. Although the dairy industry paid some attention to advertising directed at the consumer, the medical community was responsible for much of the dissemination of this innovation to the public. The high level of involvement of the medical profession in marketing milk led some to question whether milk ought to be considered a medicine instead of a food.<sup>22</sup>

Demand for vitamin D was driven primarily by the awareness-raising efforts of the public sector and the medical professionals who were themselves spurred by food industry advertising. Since the victims of rickets were primarily young children, information regarding the benefits of vitamin D–fortified milk could easily be given by physicians to mothers during routine appointments, provided the children at risk had access to physicians, and provided the physicians were properly informed. In their eagerness to win the approval of health-conscious mothers and to draw the attention of physicians, several large dairies sought the American Medical Association's seal of approval for their products. From 1933 to 1934, the AMA Committee on Foods issued a series of reports announcing the sale of vitamin D–fortified milk offered by various dairies.<sup>23</sup>

There has been no direct pressure by the federal government on the dairy industry to produce vitamin D–fortified milk: selling unfortified milk in any form except as evaporated milk violates no law. The U.S. Food and Drug Administration (FDA) established standards of identity for several forms of milk, all of which, with the exception of evaporated milk, provide for optional addition of vitamins A and D. Evaporated milk must contain added vitamin D. Nonfat dry milk that is labeled "fortified with vitamins A and D" must be fortified with those vitamins. Dairies were given special dispensation to produce vitamin D–fortified milk at a time when FDA regulations permitted vitamin enrichment only for those foods that had lost vitamins during processing.<sup>24</sup> Government agencies were also able to increase the demand for

fortified milk by their participation in the market as large-scale purchasers because technological factors made it difficult for dairies to produce both unfortified milk and the fortified products required by government contracts.

#### **IV. Adding B Vitamins and Iron to Flour and Bread**

Synthetic thiamin first became available after 1936 when Robert R. Williams announced its structure and synthesis. Yet, thiamin addition to flour did not really get started until 1941. The enrichment of bread and flour was more difficult to bring about than either of the two previous innovations. Beriberi had never impressed the general public as an obvious and common health problem the way goiter and rickets had.<sup>25</sup> The fortification program was thus more abstract, and the time required for the public to perceive benefits was much longer. This lessened the marketability of foods for beriberi prevention. Deficiencies of B vitamins were highly prevalent in the United States in the early 1900s, and about 7,000 deaths due to pellagra were reported in 1928, thus providing the impetus for cereal enrichment.<sup>26</sup>

Active efforts to enrich cereal flours and products with B vitamins and iron began in the 1930s and were stimulated by the AMA announcement of its fortification policy in 1936. At a meeting of the AMA Council on Foods and Nutrition in 1939, George Cowgill submitted a report that evaluated the nutritional status of the American public. Cowgill's report underscored the disturbing fact that the current milling process produced flour with only one-eleventh of the thiamin content of the old stone ground flour.<sup>27</sup> Cowgill cited a finding by N. Jolliffe that, given that the American diet relies on refined flour for one-fourth of its calories, the remaining three-fourths of the daily diet would have to approximate a hefty 625 grams of fruit, 600 grams of potatoes, 880 grams of vegetables, and 1,200 grams of milk to achieve adequate thiamin intake, unless one consciously attempted to select thiamin-rich foods.<sup>28</sup>

Cowgill also quoted a prior report by H. Stiebling and E. Phipard that had drawn much attention throughout the nutrition world. This report indicated that, while poor African Americans in the South achieved adequate thiamin status by consuming large quantities of whole corn meal and pork, one-tenth of Southern whites regularly selected diets that yielded only two-thirds of the established thiamin requirement.<sup>29</sup>

This was the extent of Cowgill's argument in favor of adding thiamin to flour. It relied on estimates of thiamin consumption instead of on estimates of the disease burden due to vitamin deficiency. Nevertheless, the movement to enrich flour and bread with thiamin caught on among health professionals because it was presented as insurance against nutritional deficiencies. Jolliffe stressed the need to increase our nation's "safety margin."<sup>30</sup> Although there may have been no evidence of rampant beriberi and pellagra at the time, it was argued that recent technological breakthroughs could ensure that these diseases would never become a problem.

Bakers began voluntarily enriching bread with high-vitamin yeast or synthetic vitamins in the late 1930s.<sup>31</sup> Several factors persuaded the milling

and baking industries to back the enrichment program. Pressure from nutritionists may have played a role in persuading the millers and bakers to fall in line. Robert Williams and W. H. Sebrell, two leaders of the enrichment campaign, attended the annual convention of the Millers National Federation. After appealing to the millers' philanthropy by describing the poor nutritional statistics from the South, they hinted at the possibility of federal legislation that would force the exclusive production of whole grain meals, that is, if vitamin enrichment was not supported.<sup>32</sup> Factors associated with the wartime climate may have also motivated industry support. The decision of the British to produce only enriched flour appears to have made a deep impact on the Americans.<sup>33</sup> The war in Europe may have bolstered a patriotic incentive for the food industry to do its part to keep the United States strong. Food fortification could take on the highly positive cultural function of providing vigor and energy to the nation's defense. An advertisement for enriched bread during the war featured the picture of a soldier with the caption, "What has toast got to do with winning the war?" followed by "The extra vitamins and minerals in enriched white bread help restore energy . . . to give you the added punch you need to tackle your war job."<sup>34</sup> However, the attempt to create a new patriotic meaning for vitamin fortification would ultimately play a minor role in achieving widespread fortification of flour and bread.

Despite the incentives set up by the nutritionists to persuade millers and bakers to lead the flour enrichment campaign, the program achieved only limited success between 1941 and 1942. By January 1942, the percentage of the nation's flour that was enriched had risen to only 40%.<sup>35</sup> The problem was that returns to scale in flour fortification made the marginal cost per bag of enriched flour only negligibly higher than the unenriched product for large mills but not for the smaller ones. While large mills could produce enriched flour without having to pass the extra cost to consumers, small mills could not fortify without also increasing the price of the enriched product. Although the large mills produced enriched flour, the small mills avoided doing so, because it would have destroyed their ability to compete with nationally advertised brands on the basis of price. The conservative strategy was for the small mills to wait for the demand for fortified products to increase to such an extent that consumers would pay the additional cost for enriched flour.<sup>36</sup>

Some producers chose not to "wait and see," but by early 1942, several millers and bakers began to reverse their decision to produce enriched products.<sup>37</sup> Despite the marketing efforts and appeals to patriotism, demand for enriched flour had not materialized sufficiently to make its production profitable. The National Nutrition Program to help publicize enriched flour, which had been started in 1941 with industry funding,<sup>38</sup> began to flounder in what is described as a "quagmire of unintelligible scientific talk about micrograms and milligrams."<sup>39</sup> The unintelligibility of preventing deficiencies or health problems that were not well known or well recognized rendered this innovation less appealing and slowed its progress.

Fearing for the success of their program, nutritionists sought government

intervention to help bread and flour enrichment take hold. In February 1942, the army decided that it would purchase only enriched flour. Originally, the army had decided not to take such a step, recognizing that the diet of its men was superior to civilian diets and, thus, from their own standpoint, such a decision was not necessary.<sup>40</sup> However, after a pressure campaign by nutritionists who pointed out that the army's decision might bring "advertising benefits" that would help the National Nutrition Program and result in better civilian health, the army reversed its decision. After all, the civilian population was the source of military recruits. In the end, market forces, advertising, and even the army's buying habits were not enough to bring about 100% compliance in the milling and baking industry. In areas beyond the reach of large-scale food producers, the small mills and bakeries could still undercut their small competitors' prices by producing unenriched products.

Nutritionists worried that the poor, who were most at risk of deficiency and who needed the fortified foods the most, would buy the cheaper, unfortified brands.<sup>41</sup> The solution to this problem was the enactment of legislation mandating exclusive production of enriched flour and bread. In the 1940s, several states enacted mandatory enrichment laws of various grain products.<sup>42</sup> South Carolina was the first state to heed the nutritionists' call for legislation.<sup>43</sup> Other states soon followed suit. By 1950, 26 states (of a total of 48 states at the time) and 3 territories had instituted mandatory laws requiring the enrichment of cereal flour and bread.<sup>44</sup>

In 1943, the War Foods Administration issued the War Food Order No. 1, which made enriched bread the temporary law of the land. In 1941, the Food and Nutrition Board, a unit of the Institute of Medicine, officially adopted a resolution encouraging the enrichment of flour and bread. The National Research Council, the principal operating agency of the National Academy of Sciences (NAS), and the National Academy of Engineering also prepared a special report to assist state legislators in evaluating the policy of food fortification.<sup>45</sup> Subsequently, the American Baking Association (ABA) undertook efforts to educate bakers about enrichment technology, and the government and industry worked together to launch a promotional campaign through mass media advertisements, publications, and the *Listen America* radio program.<sup>46</sup> This promotional campaign played an important role in increasing consumer awareness and demand for enriched food products.

Today, the FDA has set standards of identity for both "flour" and "enriched flour" so the sale of unenriched flour is not prohibited as long as the product meets the labeling requirement. Nevertheless, given current consumer interest in nutrition value-enhanced products, most flour currently sold for household use is enriched with B vitamins, iron, and folate.

A recent evaluation of the possible health impact of niacin fortification of flour and bread in the United States showed that food fortification played a significant role in the decline of pellagra-attributed mortality in the 1930s and 1940s and, finally, in the elimination of pellagra in the United States.<sup>47</sup>

### V. The U.S. Food Industry's Calcium Craze

In 1980, the FDA finalized its fortification policy that provides a set of guidelines to be followed by food manufacturers who fortify foods. Although the policy is clearly not intended for widespread food fortification, the trend of calcium addition to foods in the U.S. market seems to be moving in the direction of overfortification. In the late 1980s, the U.S. food industry began to introduce calcium-fortified soft drinks, juices, and cereals. The food industry's infatuation with calcium began in the spring of 1984 when a National Institutes of Health (NIH) expert panel issued a statement listing calcium along with estrogen as the mainstays of prevention and management of osteoporosis.<sup>48</sup> In 1997, the adequate intake for calcium was increased to 1,300 milligrams per day for adolescents and to 1,000 milligrams per day for adults.<sup>49</sup> By October of 1984, the Dairy Board had launched a calcium campaign credited with turning around a slump in dairy product consumption.<sup>50</sup> In 1986, the Coca Cola Company was able to increase sales of Tab by as much as 185% in four test markets after fortifying the beverage with calcium.<sup>51</sup> *Fortune* magazine advised, "The moral of the latest health craze: if your product contains calcium, flaunt it. If it doesn't, add it and flaunt that."<sup>52</sup> In 1999, Tropicana Products, Inc., a division of PepsiCo, Inc., launched two new calcium-fortified fruit juices adding to an existing line of fortified juices.<sup>53</sup> Even follow-up infant formula, a dairy product whose nutritional rationale is a superior iron content relative to cow's milk, has a label highlighting the calcium content in large letters leaving iron content to be listed in the fine print.

From a historical perspective, this situation is unusual in several ways. Most notable is the lack of participation by the health profession in formally planning this campaign. Another anomaly is the energy with which the food industry began to market nutrition. Conventional wisdom in the food industry used to be that, as a selling point, nutrition comes in a poor third behind looks and taste.<sup>54</sup> As the millers' and bakers' experiences show, problems in communicating the abstract benefits of nutrition are well known to the food industry. As a result, the food industry had been reluctant to emphasize the nutritional aspects of its products. In fact, impatience with the industry's reticence to sell nutrition led several nutritionists in the early 1970s to call for change.<sup>55</sup> The eagerness with which the food industry, once reluctant to mention nutrition, unilaterally introduced fortified foods indicates their perception of an increased market for nutrition. The food industry perceived a heightened awareness of health issues among the American people. About 66% of shoppers in 1999 tried to increase their use of fortified foods to maintain good health, an increase from 10% in 1997.<sup>56</sup> What is more, after all these years, both private industry and the general public are so comfortable with the concept of fortified food that they are willing enough and bold enough to create, sell, and buy it without the participation of a public health campaign and despite federal efforts to discourage such independent activity.<sup>57</sup> With calcium fortification, American firms created a new era in the history of food

fortification, one in which profitability, even more than disease prevention, governed policy.

## **VI. Discussion**

After 80 years of cultural adaptation to the notion of fortified food, U.S. consumer demand for some nutrients is sufficient to make industry efforts self-sustaining and even profitable. This contrasts with the great difficulty some developing countries are having in maintaining food fortification programs without the continued prop of donor funding and legal mandates. To see how food fortification campaigns in developing countries might become sustainable, we will contrast selected developing country food fortification experiences with the historical record of the American experience.

### *The Relevance of United States Experiences for Developing Countries*

Successful achievement of food fortification has a complex relationship to the level of economic development. Obvious prerequisites for food fortification include modern food-processing facilities, quality control and monitoring systems, distribution infrastructure, and regulatory support.

In many less developed countries, food-processing industries are not well established, and existing infrastructure does not facilitate reaching the population segments that most need the fortified food. Rural populations often grow and process their own staple foods; commercially processed staple foods may be unaffordable or inaccessible to many subsistence farmers. Yet, pinpointing the cause of failure in a food fortification effort is rarely as simple as noting that the market for processed food has not developed in a country.

Economic factors present a major challenge as well. The marginal cost of fortified products remains quite low. For example, in Central America, the cost of fortifying sugar with vitamin A at US\$9.08 per metric ton represents about 1.75% of the retail price of sugar. The cost of the program breaks down to about US\$0.30 per person per year.<sup>58</sup> Fortifying salt with iodine adds 5%–10% to the retail price of salt.<sup>59</sup> The total cost of fortifying wheat flour with iron and B vitamins in Guatemala at US\$0.73 per metric ton of flour represents less than 0.5% of the retail price of flour.<sup>60</sup> Even in comparison to the Guatemalan gross domestic product (GDP) per capita of \$3,900 (1999 purchasing power parity adjusted U.S. dollars), these expenditures for personal health are negligible relative to their high return in health and prevented disability. Nevertheless, in the presence of subsidies and price controls of staple food products, which are often seen in developing countries, food companies operate on thin profit margins and are not willing to take on the additional cost of fortification unless assured of consumer demand.

Our review suggests that more subtle factors may be crucial for the success of food fortification. The experience of the United States shows that conducting food fortification in a market economy is greatly enhanced by having relatively few firms in an industry and by the ability of these firms

to successfully advertise the superiority of fortified products. Large-scale purchases of fortified foods by government can also play an important role. Health consciousness has become a part of U.S. consumer culture. Health-conscious consumers believe that they can understand and make choices that affect their health and that such choices are worthwhile even at the nominal additional cost of fortified foods.

#### *Industrial Concentration in Food Production*

Industrial concentration refers to the presence of relatively few and large firms in an industry. Concentration aids food fortification by lowering the costs of quality monitoring by the government, easing the access to capital for technological change, and by increasing the returns to advertising a brand identity.

In many developing countries, a considerable proportion of food production and processing takes place at the household or village level, and numerous small-scale food producers provide the bulk of the product consumed in the country. For example, there are about 9,000 salt producers in India, of whom about 8,500 are small-scale producers. Although fortification technology is simple, the food must be fortified by trained personnel, and a proper quality control system should be in place for fortification to be safe and effective.<sup>61</sup> As the number of processors of a particular food decreases, mandatory fortification of that food becomes more feasible, because trained personnel become relatively less scarce, and because government supervision becomes less costly. These phenomena were clearly visible in the spread of enriched flour and bread in postwar United States.

When there are fewer firms in a food market, each is more likely to have succeeded in achieving a brand identity for its product. An advertising campaign by the private industry to associate the benefits of fortification with a particular brand can both increase sales and stimulate rivals to follow suit. Spontaneous private expenditure for advertising fortification to assist in developing brand identity can spare government and donor funds from being devoted to social marketing.

Concentration implies not only fewer firms but also larger firms. On the one hand, larger food companies with modernized food manufacturing systems have an advantage in adopting fortification technology due to higher returns to scale. The fixed costs of the fortification machinery and training can be distributed across more products. The small- and medium-scale producers, on the other hand, have difficulty complying with fortification regulations given their lack of or limited capacity to fortify and may eventually be driven out by competitive market forces. In such instances, donor agencies and governments in developing countries have made attempts to organize local producers' associations, provide financial assistance, build capacity of the small-scale producers, and improve the quality of the fortified product. For example, efforts in salt iodization throughout the world and maize flour/meal fortification in sub-Saharan Africa are typified by efforts to increase the capacity

of small- and medium-scale manufacturers to produce a quality fortified product.<sup>62</sup> The difficult task of effectively monitoring the compliance of a large number of food producers, however, still remains.

#### *Monitoring and Enforcement*

Unlike in the United States, developing country fortification experiences have relied extensively on mandatory legislation as key to achieving sustainability of a food fortification program. Several developing countries have set in place and enforce mandatory fortification laws that require the addition of vitamin A or iron to staple foods, including cereals, cooking oils, margarine, milk, and sugar.<sup>63</sup> In South Africa, a maize-enrichment program launched in 1983 without compulsory legislation was declared a failure after 10 years.<sup>64</sup> Moreover, voluntary fortification of nonstaple foods commonly initiated by the private industry does not reach the target population groups at risk for nutritional deficiencies. Legislation presupposes an effective monitoring and enforcement system based on the partnership of relevant food industries and governmental agencies.<sup>65</sup> Much of the U.S. early fortification of salt and milk was based on public-private partnership without regulation. The U.S. experience with flour and bread enrichment also underscores the importance of government-industry partnership. Cooperation between government and food-processing firms has been shown to be essential whether or not there is mandatory fortification.

In such a partnership, the government seeks improved public health, and the firm seeks protection against competition with unfortified products. Unfortified products locally produced or filtering in from neighboring countries cost less, and consumers often opt for the unfortified product even in the presence of public and private promotion campaigns for fortified products. In such cases, the industry has little incentive to fortify the product or fortify at the specified levels of nutrients.

Several countries are striving to develop effective monitoring systems starting with clear regulations for fortified foods, enforcement procedures and guidelines, and building capacity of responsible government units. Minimum quality standards for fortified foods at the production plant and retail market are being developed. During 1997–98, Central American countries reached a consensus with respect to fortification regulations on sugar, flour, and salt and established regional harmonization of food standards to promote trade and improve the quality of the processed foods.<sup>66</sup> Practices such as universal labeling of fortified foods are under consideration as powerful tools for monitoring and consumer education.<sup>67</sup>

#### *Sustainability*

Sustainability of fortification programs ultimately depends on a cultural change in which consumers perceive the benefits of fortified food to such an extent that they are willing to select and demand the nutritionally improved products. Both the public and private sectors can help develop the long-term consumer

culture that demands a nutritional food product. Efforts to create consumer demand that involve the mass media, education through schools, and other community mobilization activities can help convey the adverse effects of nutritional deficiencies and the health benefits of the fortified foods to consumers. In the interim, fortification will depend on strong commitment from the government and expectations of cultural change by private firms. Domestic economic, political, and market environments as well as international trade factors affect the delicate balance of fortification efforts initiated by the public sector for its potential public health benefits and undertaken by the private sector for its value-added aspect. The very early involvement of the private sector in sugar fortification in Guatemala, El Salvador, Honduras, and Nicaragua and the Philippine experience with margarine fortification favorably echo the U.S. experience of the 1920s and 1930s.<sup>68</sup>

However, even where partnerships between public and private sectors have led to a successful launch of food fortification, governments sometimes waver in their commitment to minimize the damaging effects that international trade can have on food fortification. For example, in Guatemala, where sugar fortification with vitamin A is mandated, the government has made legislative changes to encourage importation of nonfortified sugar to reduce the difference between local and international sugar prices.<sup>69</sup> Another example is the sugar fortification program initiated in 1998 by a partnership between public and private sectors in Zambia. The Zambian program is now threatened by economic constraints faced by the sugar processor partly because of the falling international price of sugar and the continuous infiltration of cheaper, unfortified sugar from neighboring countries.

Indeed, price controls and value-added tax played important roles in dairy fortification in Brazil and sugar fortification in Guatemala.<sup>70</sup> Governments and donors can play a helpful role in these areas to make fortification more attractive to the industry by providing financial relief and creating consumer demand. While the cost of fortification is eventually to be passed on to the consumer, policy makers stress the indispensability of a transition period of cost sharing and public financial involvement.<sup>71</sup> The U.S. experience shows that the government and health professionals played crucial roles in promoting and increasing the demand for fortified foods, for example, through the use of fortified foods in military ration and the sanction of the American Medical Association.

## VII. Summary

The U.S. success with sustaining food fortification depended on the cooperative dissemination of an innovation involving advertising by private industry, appropriate government action, counseling by private health care providers, and public health campaigns. The success was accelerated by intentional efforts to communicate a positive cultural meaning to food fortification as a means to protect children from well-known and visible diseases, such as goiter or rickets, or, in the case of B vitamins and iron enrichment,

to reduce the burden of pellagra and strengthen the vitality of the population. Concentration of food production among fewer and larger firms made implementation easier.

Contemporary food fortification campaigns in developing countries are faced with several challenges in public health innovation. Strong development of a local food-processing industry, the commitment and support of local governments through effective legislation and monitoring, and a consumer culture that perceives gains from investing nominal amounts for personal health continue to be key factors in the long-term success of fortification programs.

The determining role of cultural change in the long-term success of fortification in the United States underscores the need for caution in adopting the American market-based approach to fortification. In the long run, a culture that is willing and able to pay for better nutrition will make fortification sustainable, because costs could then be borne by the actual beneficiaries, and not donors or governments.

#### Notes

\*We gratefully acknowledge the financial support of the Hopkins Population Center (5P30 HD0628–25). The opinions expressed herein are ours and do not necessarily reflect the views of the U.S. Agency for International Development or the MOST project. We are grateful for helpful comments made by Youngmee Park, Penny Nestel, Jose Mora, and Omar Dary. All errors are our own.

1. D. S. Titus, "The Technology of Iron Fortification," in *Nutrition and Food Science: Present Knowledge and Utilization*, ed. W. Santos (New York: Plenum, 1980); B. S. Hetzel, "Iodine Deficiency Disorders (IDD): A Maternal and Child Health Issue," in *Advances in International Maternal and Child Health*, ed. Derrick B. Jelliffe and E. F. Patrice Jelliffe (Oxford: Clarendon, 1986); J. Price and M. T. Theodoros, "The Supplementation of Alcoholic Beverages with Thiamine—a Necessary Preventive Measure in Queensland?" *Australian and New Zealand Journal of Psychiatry* 13 (1979): 315–20.

2. G. G. Harrison, "Consumer Acceptability," in *Global Malnutrition and Cereal Fortification*, ed. J. Austin (Cambridge: Ballinger, 1979); S. N. Gershoff, "Food Fortification," in *Nutritional Policies Implementation*, ed. N. S. Scrimshaw and M. B. Wallerstein (New York: Plenum, 1982); Council on Foods and Nutrition, "Improvement of Nutritive Quality of Foods," *Journal of the American Medical Association* 205 (1968): 868–69; Food and Drug Administration, "Nutritional Quality of Foods: Addition of Nutrients," *Federal Register* 18 (1980): 6314–24.

3. Robert R. Williams, *Toward the Conquest of Beriberi* (Cambridge: Harvard University Press, 1961); Howard Markel, "'When It Rains It Pours': Endemic Goiter, Iodized Salt, and David Murray Cowie," *American Journal of Public Health* 77 (1987): 219–29; Youngmee K. Park, Margaret M. McDowell, Eric A. Hanson, and Elizabeth A. Yetley, "History of Cereal-Grain Product Fortification in the United States," *Nutrition Today* 36, no. 3 (May 2001): 124–42.

4. David Marine and O. P. Kimball, "The Prevention of Simple Goiter in Man," *Journal of the American Medical Association* 77 (1921): 1070.

5. David Marine, "On the Occurrence and Physiological Nature of Glandular Hyperplasia of the Thyroid (Dog and Sheep) Together with Remarks on Important Clinical (Human) Problems," *Bulletin of Johns Hopkins Hospital* 18 (1907): 359.

6. R. M. Olin, "Iodine Deficiency and Prevalence of Simple Goiter in Michigan," *Journal of the American Medical Association* 82 (1924): 1328–32.
7. Marine and Kimball.
8. Harry G. Sloan, "The Use of Iodized Table Salt in the Prevention of Goiter," *Ohio State Medical Journal* 17 (1921): 172.
9. Curtis Fertman, "Iodine," in *Handbook of Nutrition*, ed. G. Mildred (Chicago: American Medical Association, 1943).
10. Markel.
11. Advisory Committee of the Pediatric Section of the Michigan State Medical Society, "A Study of the Effect of the Use of Iodized Salt on the Incidence of Goiter," *Journal of the Michigan State Medical Society* 36 (1937): 647–55.
12. D. Peterkin, Michigan Historical Collection, Bentley Historical Library, University of Michigan, November 20, 1923.
13. Advisory Committee of the Pediatric Section, Society M. S. M., Iodized Salt (1924).
14. W. Hutchinson, "Please Pass the Iodine," *Saturday Evening Post* (January 3, 1925), p. 22.
15. Advisory Committee of the Pediatric Section of the Michigan State Medical Society.
16. Ibid.
17. Lawrence A. Kohn, "Goiter, Iodine, and George W. Goler: The Rochester Experiment," *Bulletin of the History of Medicine* 49 (1975): 389–99.
18. U.S. Government, *Title 21 Code of Federal Regulations* (Washington, D.C.: U.S. Government Printing Office, 2000).
19. S. J. Cowell, "Irradiation of Milk for Rickets in Children," *British Medical Journal* 1 (1935): 587–642.
20. Alfred F. Hess, "The Role of Activated Milk in the Anti-rickets Campaign," *American Journal of Public Health* 22 (1932): 1215–19.
21. "Caution Needed in the Commercialization of Vitamin D," *Food Industries* 1 (1928): 97–98.
22. E. L. Weart, "Milk: A Food or a Medicine," *New Republic* 93 (1938), pp. 359–61.
23. American Medical Association, Committee on Foods, "Vitamin D Fortified Pasteurized Milk (150 Units per Quart) Advertising of W. J. Kennedy Dairy Company," *Journal of the American Medical Association* 101 (1933): 34.
24. "Vitamins Get a Book of Rules," *BusinessWeek* (April 6, 1940), pp. 40–43.
25. Russell M. Wilder and Robert R. Williams, *Enrichment of Flour and Bread: A History of the Movement Council* (Washington, D.C.: U.S. Government Printing Office, 1944).
26. Park, McDowell et al. (n. 3 above).
27. George R. Cowgill, "The Need for Addition of Vitamin B1 to Staple American Foods," *Journal of the American Medical Association* 113 (1939): 2146–54.
28. N. Jolliffe, "A Clinical Evaluation of the Adequacy of Vitamin B1 in the American Diet," *International Clinician* 4 (1938): 46–66.
29. H. Stiebling and E. Phipard, *Diets of Families of Employed Wage Earners and Clerical Workers in Cities* (Washington, D.C.: U.S. Department of Agriculture, 1939).
30. Jolliffe.
31. Park, McDowell et al.; Youngmee K. Park, C. T. Sempos, C. N. Barton, J. E. Vanderveen, and Elizabeth A. Yetley, "Effectiveness of Food Fortification in the United States: The Case of Pellagra," *American Journal of Public Health* 90 (2000): 727–38.
32. "Millers Endorse Program of Flour Enrichment," *Food Industries* 14 (1942): 77.

33. "Britain Fortifies Its Food," *Food Industries* 12 (1940): 37–38.
34. Paid advertisement in *Journal of the American Dietetic Association* 18 (1942): 211.
35. "Nutrition Fiasco," *BusinessWeek* (March 7, 1942), pp. 50–52.
36. "Nutrition Splurge," *BusinessWeek* (April 11, 1942), pp. 48–49.
37. Ibid.; "Bakers and Public Backslide on Use of Enriched Bread," *Science Newsletter* 41 (1942): 84.
38. "Bread Campaign," *BusinessWeek* (March 15, 1941), pp. 70–71.
39. "Nutrition Splurge."
40. "Army Wants Only Enriched Flour," *Food Industries* 14 (1942): 69.
41. Wilder and Williams (n. 25 above).
42. Park, McDowell et al. (n. 3 above); Park, Sempos et al. (n. 31 above).
43. American Institute of Baking, "Enriched Bread a Law in One State, a Good Rule Everywhere," *Journal of the American Dietetic Association* 18 (1942): 547.
44. Park, McDowell et al.; Park, Sempos et al.
45. Wilder and Williams.
46. Park, McDowell et al.
47. Park, Sempos et al.
48. "The Calcium Craze," *Newsweek* 107 (January 27, 1986), p. 48.
49. National Academy of Sciences, *Dietary Reference Intakes for Calcium, Phosphorus, Magnesium, Vitamin D, and Fluoride* (Washington, D.C.: Institute of Medicine, National Academy Press, 1997).
50. "Dairies Spin the Bottle for Nutritious Items," *Advertising Age* (November 10, 1986), p. 86w.
51. "Calcium, It's Practically Everywhere," *Advertising Age* (December 1986), p. 29.
52. "A Lot of Hoopla over Plain Old Calcium," *Fortune* 113 (1986), p. 62.
53. P. Hollingsworth, "Food Priorities for an Aging America," *Food Technology* 53 (1999): 38–40.
54. "Advertising Nutrition," *New Republic* (March 6, 1971), pp. 7–8.
55. "Use Nutritional Info in TV Ads, Choate Urges Food Men," *Advertising Age* (March 27, 1972); "Using Ads to Help Cure Nutritional Ills, Mayer Urges," *Advertising Age* (March 23, 1970), p. 103.
56. Elizabeth Sloan, "Fortification Frenzy: The New Wellness Mindset," *Food Technology* 54 (2000): 20.
57. "FDA, USDA Food Fortification Policy," *Food Processing* 43 (1982): 10–11.
58. J. Mora, O. Dary, and G. A. D. Chinchilla, *Vitamin A Sugar Fortification in Central America: Experience and Lessons Learned* (Washington, D.C.: MOST/U.S. Agency for International Development, 2000).
59. Food and Agriculture Organization (FAO) and International Life Sciences Institute, *Preventing Micronutrient Malnutrition: A Guide to Food-Based Approaches: A Manual for Policy Makers and Programme Planners* (Washington, D.C.: International Life Sciences Institute Press, 1997).
60. O. Dary, "Sugar Fortification with Vitamin A: A Central American Contribution to the Developing World," in *Food Fortification to End Micronutrient Malnutrition—State of the Art: Symposium Report* (Montreal: Micronutrient Initiative, 1998).
61. P. Nestel, *Food Fortification in Developing Countries* (Washington, D.C.: U.S. Agency for International Development, 1993).
62. FAO; L. Laleye, "Fortification in Small-Scale Mills," in *Enhancing the Nutritional Quality of Relief Diets: Workshop Proceedings* (Washington, D.C.: Food Aid Management, April 1999), see also Web citation at <http://www.foodaidmanagement.org/reliefdiets.html>.
63. *Mandatory Food Enrichment* (Basel: Nutriview, 2000).

64. United Nations International Children's Emergency Fund (UNICEF), *The State of the World's Children, 1998: Panel 17—Making Food Enrichment Programmes Sustainable* (New York: UNICEF, 1998).

65. FAO; Jack Bagriansky, *Sharing Risk and Reward—Public-Private Collaboration to Eliminate Micronutrient Malnutrition: Report of the Ottawa Forum on Food Fortification* (Washington, D.C.: U.S. Agency for International Development, Opportunities for Micronutrient Interventions, 1996).

66. I. Darnton-Hill, J. Mora, H. Weinstein, S. Wilbur, and R. Nalubola, "Food Fortification to Reduce Micronutrient Deficiencies: Lessons Learned from Latin America" (paper presented at the annual meeting of the Institute of Food Technologists, Dallas, 2000); I. Darnton-Hill, J. Mora, and H. Weinstein, "Iron and Folate Fortification in the Americas to Prevent and Control Micronutrient Malnutrition: An Analysis," *Nutrition Review* 57 (1999): 25–31.

67. Mora et al.

68. Ibid.; Dary, "Sugar Fortification with Vitamin A"; FAO (n. 59 above); F. Solon, "A Case Report on the Fortification of Margarine with Vitamin A: The Philippine Experience," in *Food Fortification to End Micronutrient Malnutrition* (n. 60 above).

69. Omar Dary, personal communication, 2000.

70. UNICEF; Mora.

71. Asian Development Bank, Micronutrient Initiative, and International Life Sciences Institute, *Manila Forum 2000: Strategies to Fortify Essential Foods in Asia and the Pacific* (Manila: Asian Development Bank, 2001).