Rice Fortification in Costa Rica

Case study

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Key Messages

- Costa Rica's long history of food fortification provided the knowledge base and legislative experience for implementing a successful mandatory rice fortification program.
- Engaging food manufacturers and rice millers, and leveraging existing distribution channels, created a sustainable fortification program.
- The public and private sector share costs to develop and support ongoing quality management and monitoring.
- The technology and fortificants used produce fortified rice kernels that are acceptable in taste and appearance to consumers.

Seal of quality as fortified food in Costa Rica

Introduction

With a population of approximately four million people, Costa Rica has a long history of government policies to improve the country's public health. Public health initiatives include large-scale food fortification, strengthening the primary health care system, sanitation improvements, and deworming campaigns.

All rice consumed in Costa Rica is fortified with folic acid, vitamins B_1 (thiamin), B_3 (niacin), B_{12} (cobalamin), E, selenium and zinc. As a staple food, 60% of the rice is domestically produced. The fortification of rice, along with that of other staple foods and condiments, helps to increase micronutrient intake. Per capita rice consumption averages 150 g per day, providing approximately 30% of caloric intake. Rice is relatively affordable, and is about 9% of the cost of the basic food basket.

Costa Rica's success in large-scale rice fortification is primarily due to its food fortification experience, its centralized rice industry, government leadership, and private sector support. This article describes Costa Rica's fortified rice program and analyzes the key factors in its success.

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Staple food fortification in Costa Rica

Micronutrient fortification of staple foods and condiments in Costa Rica began in 1974 with the iodization of salt in response to continued micronutrient deficiencies. Despite the implementation of a basic sanitation and deworming program, primary health care strategy, supplementation, health promotion, and complementary feeding activities to improve micronutrient health, the 1996 national nutrition survey found that micronutrient deficiencies

TABLE 1: Overview of fortified foods, fortificants and fortification levels in Costa Rica

Food	Average daily consumption	Fortificants	Fortification level
Rice	130 g	Folic acid (vitamin B_9)	1.8 mg/kg
		Thiamin (vitamin B_1)	6.0 mg/kg
		Cobalamin (vitamin B_{12})	10.0 µg /kg
		Niacin (vitamin B_3)	50.0 mg/kg
		Vitamin E	15.0 IU/kg
		Selenium	105.0 µg/kg
		Zinc	19.0 mg/kg
Sugar	71.4 g	Vitamin A	8 mg/kg (26,664 IU/kg)
Wheat flour	74 g	Thiamin (vitamin B_1)	6.2 mg/kg
		Riboflavin (vitamin B_2)	47.2 mg/kg
		Niacin (vitamin B_3)	55 mg/kg
		Folic acid (vitamin B_9)	1.8 mg/kg
		Iron (Ferrous fumarate)	55 mg/kg
Milk	107 mL	Iron (Ferrous bisglycinate)	1.4 mg/250 mL
		Vitamin A	180 µg/250 mL
		Folic acid (vitamin B_9)	40 µg/250 mL
Maize flour	18.0 g	Iron (Ferrous bisglycinate)	22 mg/kg
		Niacin (vitamin B_3)	45 mg/kg
		Thiamin (vitamin B_1)	4 mg/kg
		Riboflavin (vitamin B_2)	2.5 mg/kg
		Folic acid (vitamin B_9)	1.3 mg/kg
Salt	9.8 g	Iodine	30–60 mg/kg
		Fluoride	175–225 mg/kg

remained at critical levels.[1] In addition, a study based on data from the nation's Congenital Disease Registry showed that 12 in 10,000 infants had neural tube defects.[2]

In response, the government established a cross-sectoral National Micronutrient Commission and expanded its fortification efforts, in partnership with the private sector. Mandatory fortification of wheat flour began in 1997, followed by corn flour in 1999, milk and rice in 2001, and sugar in 2003. See **Table 1** for an overview of the fortified foods in Costa Rica and the fortification level.

Legislative framework for rice fortification

In 2001, the Presidency of the Republic and the Ministry of Health enacted the "Regulations for the Enrichment of Rice." The legal framework for rice fortification was placed under the umbrella of the 1974 General Health Law. The legislation mandated that all direct for human consumption rice must be fortified, whether the rice is domestically produced or imported. The regulations defined the specific micronutrients and the required fortificant levels. In addition, the regulations assigned external monitoring and quality control to the government and internal monitoring to the rice industry.

Fortified rice supply chain

Costa Rica's rice supply chain is relatively consolidated. Two fortified kernel producers supply the 11 rice milling companies operating in Costa Rica. The millers blend the fortified kernels with non-fortified rice at the specified ratio (0.5%) and sell the fortified rice through their distribution channels. The 11 millers are brought together under the National Association of Rice Producers (ANINSA). The rice corporation (CONARROZ) is the sole entity allowed to import rice within a set quota.

Setting standards

Setting rice fortification standards started with consideration of the typical local diet, including consumption of other fortified foods. Other criteria used in selecting the micronutrients and levels of the rice fortificant premix included: the nutrient deficiencies in the population; the interaction between nutrients; the recommended nutritional intake; and the level of rice consumption. The combined micronutrient intake from fortified rice and other fortified foods was determined to be effective and safe. Based on these considerations, the standard was set to require fortification with vitamin B_1 (thiamin), B_3 (niacin), B_9 (folic acid), vitamin B_{12} (cobalamin), vitamin E, selenium, and zinc.

In Costa Rica rice is not fortified with iron and vitamin B_2 (riboflavin) for two reasons. First, tests showed that the type and concentration of iron recommended at the time (2001) produced changes in both taste and appearance that were unacceptable to consumers. Unless color change is not a problem for consumer acceptability, rice is typically not fortified with vitamin B_2 because it changes the color of fortified kernels. Second, iron and vitamin B_2 were available in other fortified commodities. Note that new formulations of iron are now available that do not impact consumer acceptability of fortified rice.

Technology

In Costa Rica, where rice is washed prior to cooking, the initial preference to fortify using dusting technology was deemed inappropriate. Dusting technology, in which polished, milled rice kernels are dusted with a fortificant mix, does not allow for washing or cooking in excess water, as this will wash out the micronutrients. Rather, coating and extrusion technologies were determined to be more suitable for the production of the fortified kernels, as nutrients are retained when rice is washed or cooked in excess water.

Currently, one of the fortified kernel producers uses coating technology and the other producer uses warm-extrusion technology. Refer to the contribution by Montgomery et al for additional information on identification of appropriate rice fortification technology (p. 159).

Quality control

Quality control and monitoring responsibilities are shared by the private and public sectors. The two fortified kernel producers are responsible for guaranteeing the micronutrient concentrations in the fortified kernels.[3] Millers are responsible for the accuracy of the blending ratios and homogeneity. For internal monitoring of the blending ratios, sampling is conducted every hour. Some sampling, along with all lab analysis, is done by third-party laboratories to determine compliance against the mandatory rice fortification executive decree. External quality control and evaluation are the responsibility of the Ministry of Health, and are performed by the government's quality control agency. These quality control samples are obtained from retailers at point of sale, as opposed to upstream sampling at manufacturing sites. Government regulations mandate labeling of all rice sold with the assigned quantities of the micronutrients' minimum amounts (per kg). The shared quality control and monitoring process enhances quality control across the supply chain.

Costs

Costs for rice fortification include initial start-up costs and ongoing costs of fortification. Initial costs included the cost of the coating and extrusion technology and the blending machinery, as well as installation and calibration. Ongoing, the primary cost components are: the micronutrient premix costs; production costs of the fortified kernels; and quality control and monitoring costs. Minor costs include blending, storage and transport. In the early days of the program, costs due to fortification rose to about 5–6% of the retail price. As fortified kernel producers and rice millers gained experience and increased production efficiencies, the additional costs fell to less than 1%. This cost-reducing gain in production efficiency is typically observed in food fortification programs. Currently, the estimated additional cost per kg of rice due to fortification is about US$ 0.01, or about 0.9% of the retail price.

Impact of micronutrient fortification programs

Although improvements cannot be attributed to any specific fortified food, national impact evaluation and monitoring programs have reported significant improvements in micronutrient status following the introduction of the food fortification program. Given the relatively large per capita intake of fortified rice as part of the overall food basket, rice fortification must have significantly contributed to these improvements in micronutrient status. Reductions in micronutrient deficiencies have been shown both within the general population and among specific groups.

> "Significant improvements in micronutrient status have been reported following the introduction of the food fortification program"

Anemia

Costa Rica's anemia prevalence rates have fallen significantly following the introduction of the national fortification program.[4] In addition to iron deficiency, anemia can also result from deficiencies in vitamin B_{12} and folate. The 2008–2009 National Survey data,[5] compared to the 1996 data,[1] showed a 71.2% reduction in the prevalence of anemia among children one to six years of age. Rural areas showed larger reductions in the prevalence of anemia (89.6%) than urban areas (74.6%). National anemia prevalence ranges from 1 to 9.9% and is no longer of public health concern (see **Figures 1** and **2**).

Among women of childbearing age, the National Nutrition Surveys in 1982, 1996[1] and 2008–09[5] showed a similar significant reduction in anemia prevalence of 46.8% at the national level. Looking at geographic areas, anemia declined 54% in rural areas, 46.3% in urban areas, and 36.4% in metropolitan areas (see **Figures 3** and **4**).

FIGURE 1: Prevalence of anemia in Costa Rican preschool children; 1982 and 1996 compared to 2008–2009.

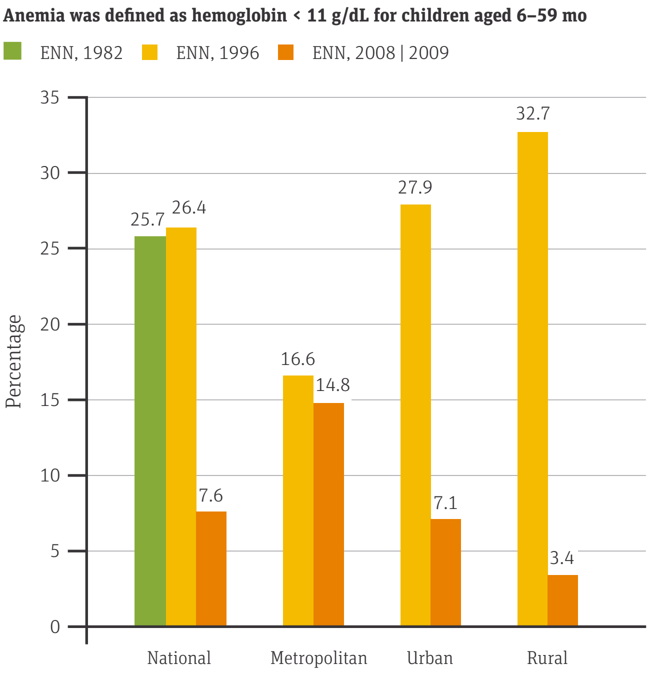
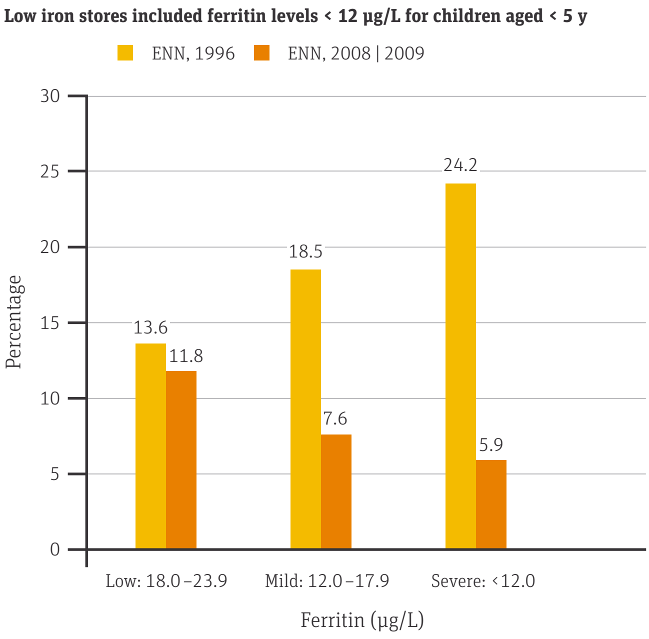


FIGURE 2: Prevalence of low ferritin in Costa Rican preschool children; 1996 compared to 2008–2009.



Neural tube defects

The combined food fortification programs have also reduced the prevalence of neural tube defects (NTDs) linked to folate deficiency. Prevalence of NTDs in newborns fell from 11 per 10,000 births in 1982–1996[1] to five per 10,000 births in 2008–2009[5] (see **Figure 5**).

Key success factors

The success of rice fortification in Costa Rica is due to the following factors:

- Government leadership

Government leadership has been crucial to the establishment and implementation of the rice fortification program. The early success of other large-scale food fortification efforts and the existence of the government's cross-sector commission created an enabling environment for the passage of mandatory rice fortification legislation. The government worked in collaboration with the private sector to ensure sustainability. In addition, the government maintained the political will for legislative monitoring and enforcement, including incentives to reinforce compliance and punishments for non-compliance.

> "Government leadership was crucial in establishing and implementing the rice fortification program"

- Sustainable partnership approach: engaging rice millers and leveraging existing distribution channels

The Costa Rican government worked in partnership with the private sector from the start of the program. Negotiations with the rice producers' association were supported, and the private sector was given sufficient time to implement the mandatory fortification. Importantly, as the price of rice is controlled, the Ministry of Economy included the cost of fortification within the cost model in determining the wholesale and retail prices.

Millers and distributors leveraged the pre-existing channels to produce and distribute the fortified rice. Two private sector food companies manufacture the fortified kernels. The government helped to study the different premix options and costs, taking into account the market price. Based on the government analysis of the most efficient supply chain structure, fortified kernel producers invested in developing blending technology to be installed at the rice millers.

Costs and responsibilities were shared between public and private sectors

A significant portion of the cost to develop a rice fortification

FIGURE 3: Prevalence of anemia in Costa Rican women of childbearing age by area; 1982 and 1996 compared to 2008–2009.

Anemia was defined for women >15 years as hemoglobin <12.0 g/dL

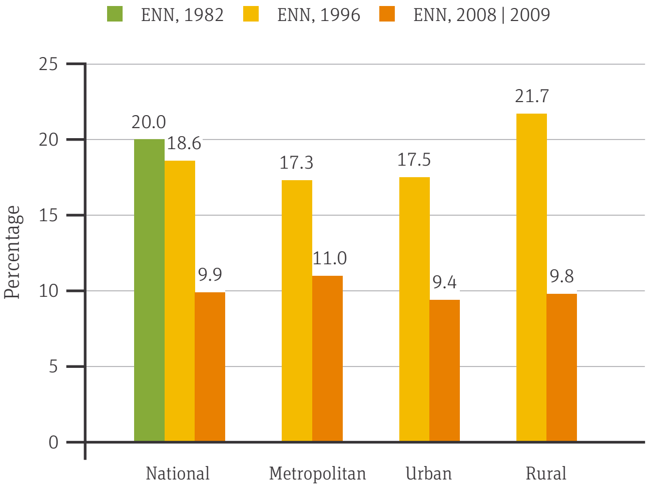
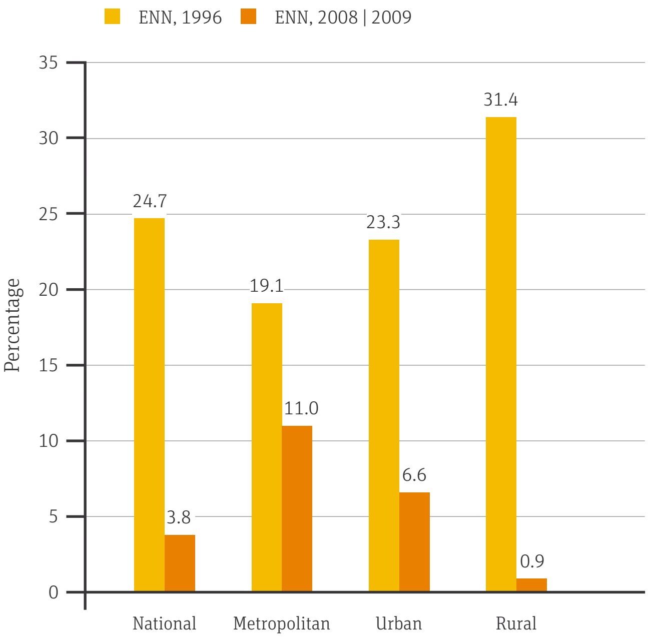


FIGURE 4: Prevalence of folate deficiency in Costa Rican women of childbearing age by area; 1996 compared to 2008–2009.

WHO cut-off values were used: <6.8 nmol/L (3 ng/mL) for serum folate and <226.5 nmol/L (100 ng/mL) for red blood cell folate.



program was covered by the private sector, thus increasing the program's sustainability. The Ministry of Health financed the health needs research, while technology development was financed by the fortified kernel producers seeking profit opportunities. Two companies, Kuruba and DSM, led technology development and premix tests for the fortified kernels. The Institute of Nutrition of Central America and Panama (INCAP) led technology assessment and micronutrient stability tests. In addition, one of the fortified kernel suppliers supported the industry by investing in the development of blending technology. Advocacy for implementation of the mandate was led by the rice producers' association, ANINSA, and the national rice corporation, CONARROZ. These private and civic sector efforts helped ensure sustainability. The government's only costs to maintain the program are the laboratory equipment and labor necessary for on-going monitoring, evaluation, and quality-control activities.

Consumer prices were controlled

The Ministry of Economy Trade and Industry controls rice prices at the wholesale and retail levels, by accounting for the added cost of fortification. Demand for rice is relatively inelastic. As mentioned previously, initially retail rice prices rose by 5–6%. However, after more experience in production helped reduce costs, retail prices fell. The current retail price increase due to fortification is only 0.9%.

It is important to note that mandatory fortification eliminated the need to create consumer demand, which has proven difficult for fortified staples. Rice distributors are able to cover the minimal increase in their costs through the government-mandated price without the need to spend additional resources on marketing and consumer demand generation.

Good consumer acceptability

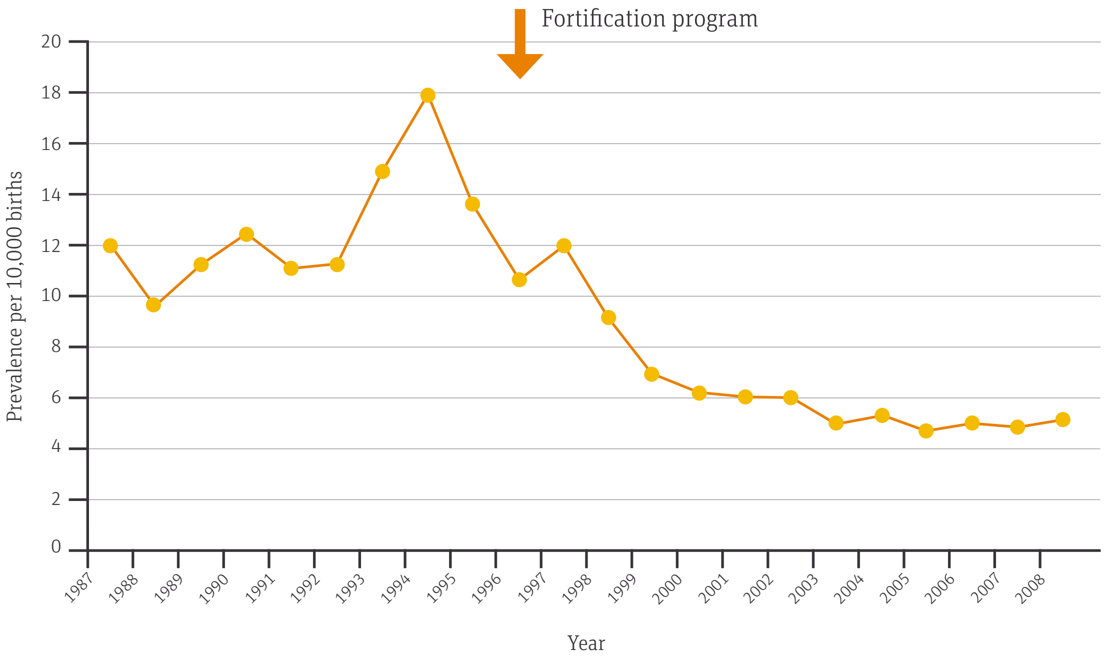
As consumers cannot tell the difference between Costa Rica's fortified and non-fortified rice, consumer acceptability is high. Tests showed that rice produced according to government standards can be washed without losing nutrients, and looks, smells and tastes the same as non-fortified rice.

> "Costa Rica's rice fortification program exemplifies successful implementation"

Conclusion

Costa Rica is a model for successful implementation of a rice fortification program. Program success is attributed to the country's experience with fortification of other commodities; the centralized rice industry; a good understanding of the rice

FIGURE 5: Birth prevalence of neural tube defects (NTDs) in Costa Rica; 1987–2008



Blending of fortified kernels with non-fortified rice at rice mill in Costa Rica

industry landscape and supply chain; strong government leadership; early involvement and support from both private and public sectors; and a strong emphasis on the importance of monitoring and compliance. The government also monitored the positive public health impact of the fortification program. Costa Rica's experience demonstrates that, when feasible, mandatory fortification is a very cost-effective delivery option. Mandatory fortification eliminates the need for price-increasing marketing efforts and consumer awareness campaigns.

Overall, the Costa Rican experience provides valuable lessons for implementing a successful rice fortification program. Although the rice milling landscape in many countries is more fragmented, making implementation more complex, from a technology, organizational and public health perspective, Costa Rica demonstrates that rice fortification can be implemented successfully, and can significantly contribute to the reduction of micronutrient deficiencies.

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