


Rice Fortification




Supply chain and technical feasibility

Evidence from 10 years of implementation around the world

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This brochure draws on the following publications:
Scaling Up Rice Fortification in Asia. Basel: *Sight and Life*; 2015.
Scaling Up Rice Fortification in Latin America and the Caribbean. Basel: *Sight and Life*; 2017.
Scaling Up Rice Fortification in West Africa. Basel: *Sight and Life*; 2018 (in press)
Guideline: Fortification of Rice with Vitamins and Minerals as a Public Health Strategy. Geneva: World Health Organization; 2018.

> “Precious things are not pearls and jade but the five grains, of which rice is the finest”
>
> *Chinese proverb*

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Paddy rice harvest in Nepal

Now is the right time to scale up rice fortification

Rice fortification is the addition of essential vitamins and minerals to rice, post-harvest, to increase its nutritional value. With more than three billion people worldwide relying on rice as a staple food, rice fortification offers a unique opportunity to substantially improve nutrition and, as such, the health and economic status of a large number of people in many countries at a very low cost.

Hidden hunger

Globally, more than two billion people are affected by micronutrient deficiencies, or hidden hunger. These deficiencies, defined as the lack of one or more of the essential vitamins and minerals required for healthy growth, development, and functioning, affect all ages and socioeconomic groups. The consequences of hidden hunger, however, are particularly damaging for women of reproductive age and their children.

Hidden hunger impacts socioeconomic development at household as well as national level, and its short- and long-term consequences include maternal and child mortality, increased illness, mental retardation, and poor cognitive and physical development. All of these negatively impact a country's GDP. As affirmed by the 2008 and 2013 Lancet Series on Maternal and Child Nutrition, the 2012 Copenhagen Consensus, and the global Scaling Up Nutrition (SUN) Movement, multimicronutrient fortification is among the most cost-effective strategies to reduce malnutrition.

About this publication

This publication presents the highlights from recent *Sight and Life*–WPF joint publications on scaling up rice fortification in Asia, Latin America, and West Africa. It offers up-to-the minute data, insights, and approaches, offering an accessible and authoritative introduction to a public health intervention that has massive potential not only to reduce hunger and malnutrition around the world but also to help build thriving and confident local economies and societies.

Our thanks go to the many scientists, policymakers, programme managers, and field workers worldwide who have contributed to the advances in scaling up rice fortification made in the past decade, many of whose contributions are reflected in these pages.

Much has been achieved to date and numerous challenges remain to be overcome, but we are firmly convinced that this is only the start of a great chapter in the story of the world's battle to eliminate all forms of hunger and malnutrition.

Klaus Kraemer
Managing Director, *Sight and Life*

Lauren Landis
Director of Nutrition, World Food Programme

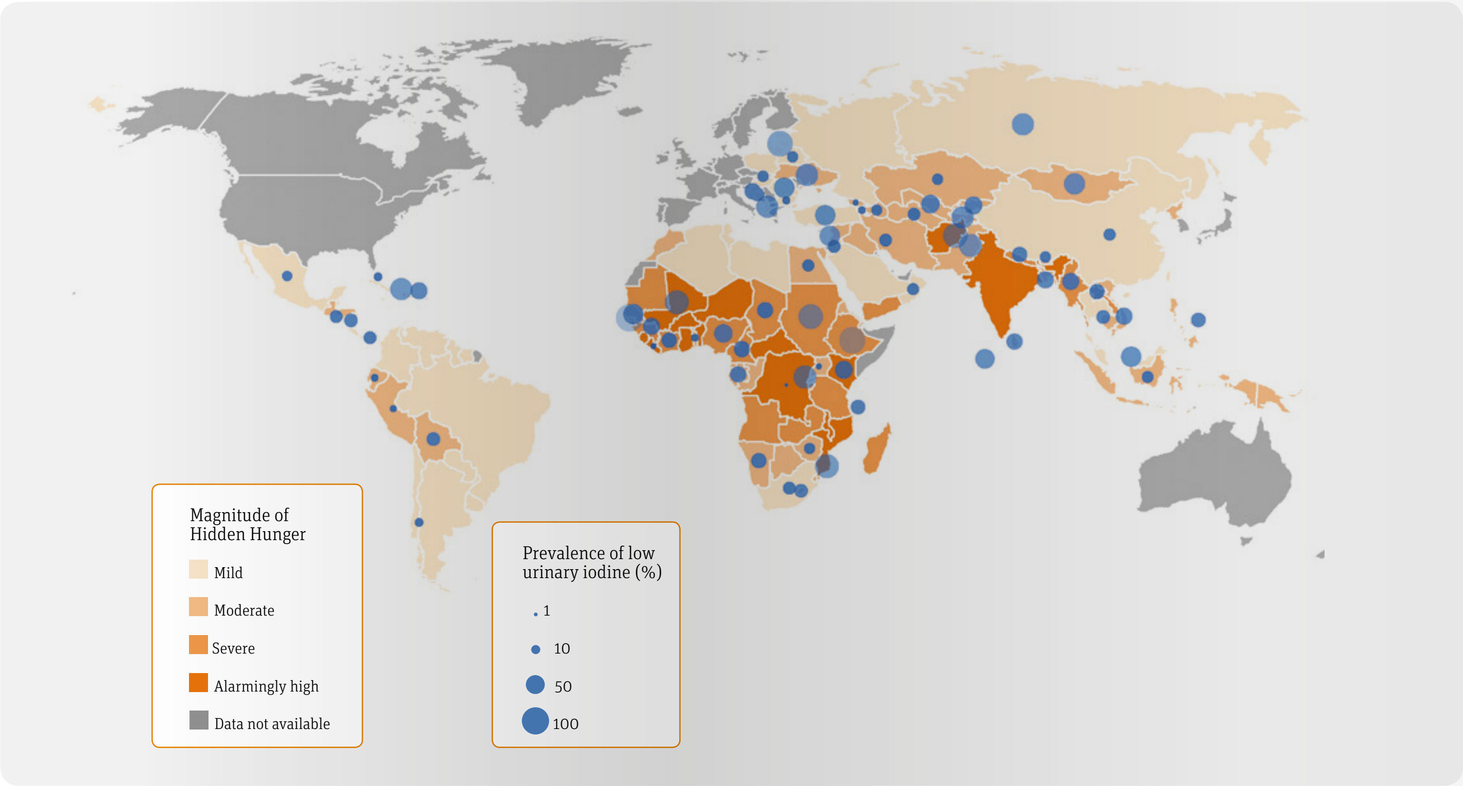
Filling the nutrient gap

Rice is a staple food for more than three billion people across the globe. In some countries, including Bangladesh, Cambodia, and Myanmar, rice contributes as much as 70% of daily energy intake. This presents a nutritional problem: milled rice is a good source of energy, but a poor source of micronutrients.

Where rice is a staple food, making it more nutritious through fortification with essential vitamins and minerals is a proven and cost-effective intervention to increase micronutrient intake among the general population.

Consumption of fortified rice increases micronutrient intake without requiring consumers to change their buying, preparation or cooking practices.

FIGURE 1: Hidden Hunger Map



Reproduced from: Scaling Up Rice Fortification in Asia, 2015.

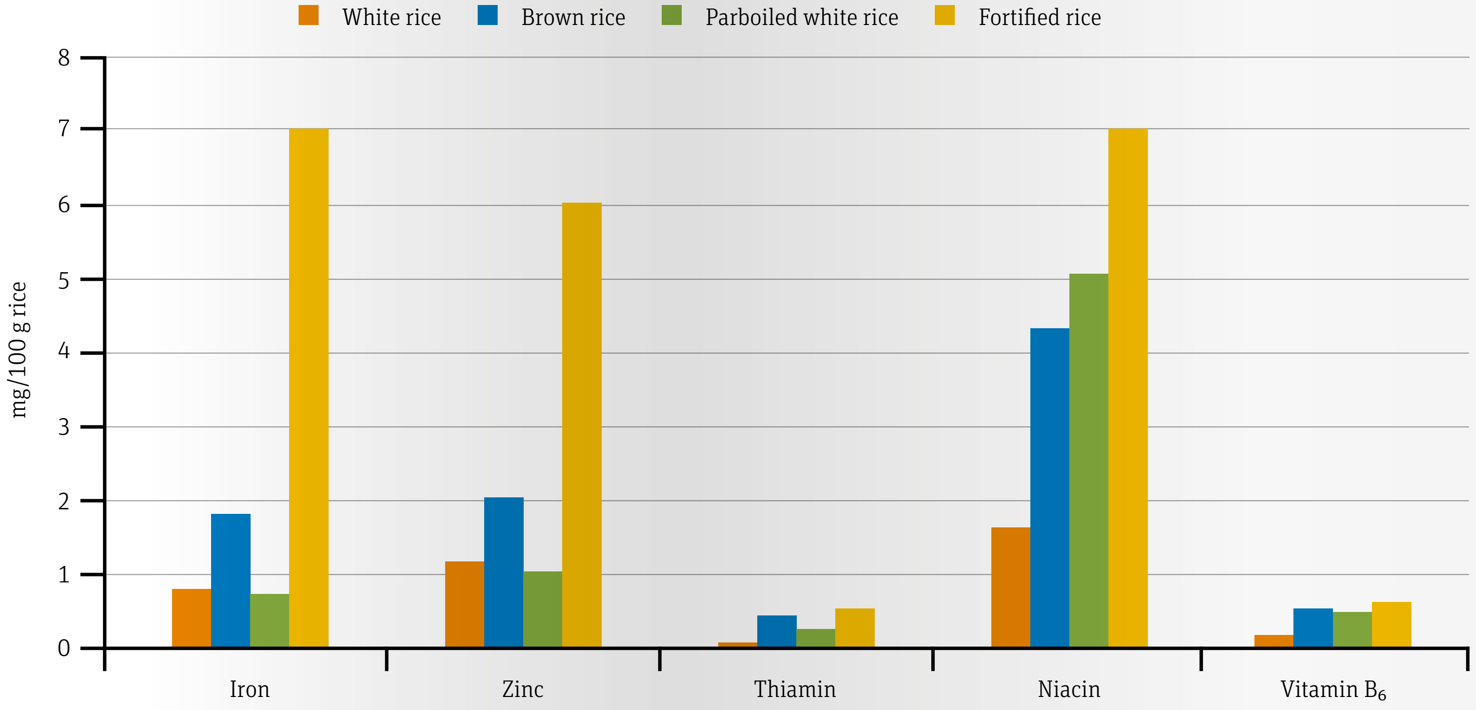
Improving the nutritional value of rice through post-harvest fortification

When fortified with multiple micronutrients, fortified rice is more micronutrient-rich than brown, parboiled, or non-fortified white rice.

Rice fortification cannot eliminate all micronutrient deficiencies; it complements other strategies such as biofortification and dietary diversification.

Supplements will continue to be important for the most vulnerable groups such as pregnant and lactating women and pre-school children.

FIGURE 2: Profile of selected micronutrients in white rice, brown rice, parboiled white rice, and fortified white rice



Reproduced from: Scaling Up Rice Fortification in Asia, 2015.

Rice fortification is effective

Multiple efficacy and effectiveness studies have established the impact of fortified rice on micronutrient status.

Given the existing evidence base, it is not necessary to conduct additional efficacy trials prior to the introduction of rice fortification.

Based on available evidence of efficacy, stability, and needs, the following micronutrients are recommended for rice fortification: iron, zinc, and vitamins A, B_1 (thiamin), B_3 (niacin), B_6 (pyridoxine), B_9 (folic acid), and B_{12} (cobalamin).

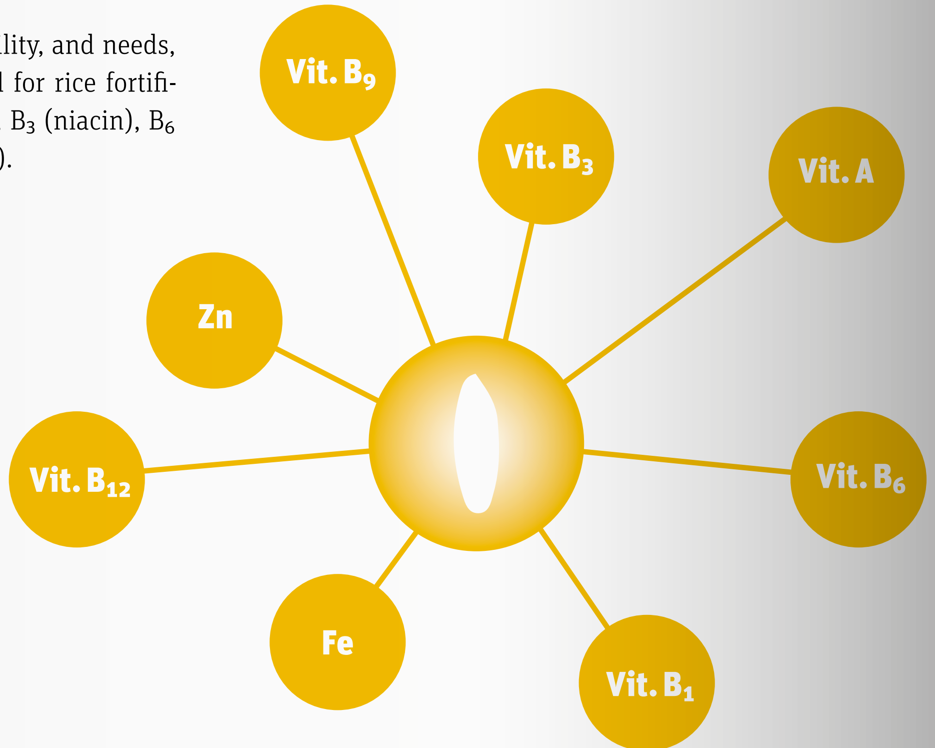
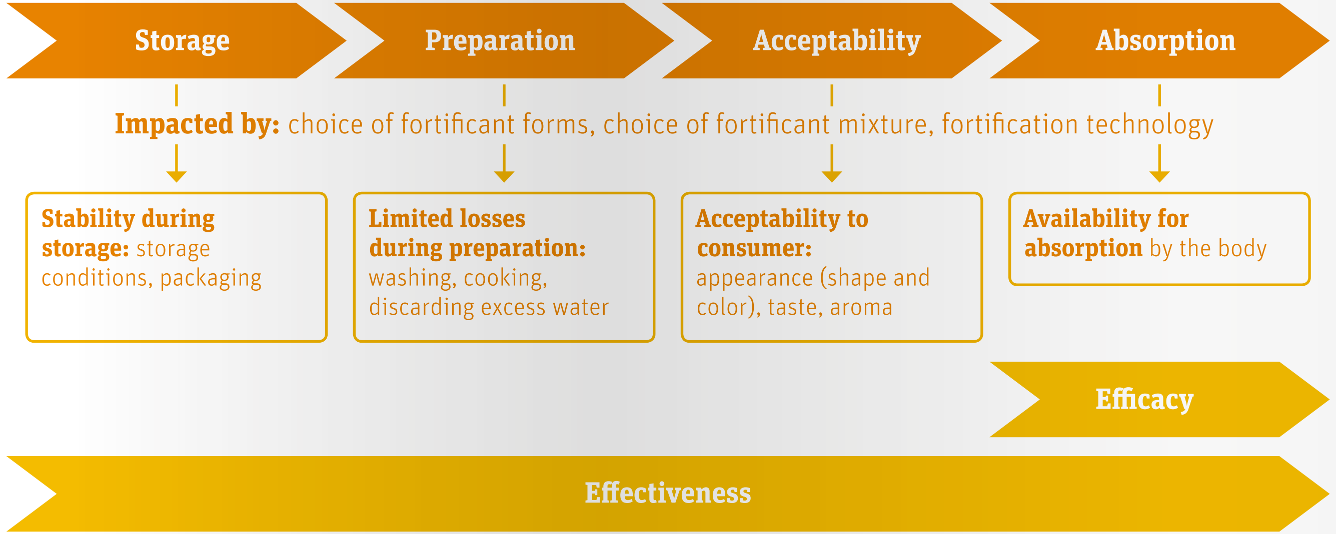


FIGURE 3: Factors that determine the efficacy and effectiveness of rice fortification



Reproduced from: Scaling Up Rice Fortification in Asia, 2015.

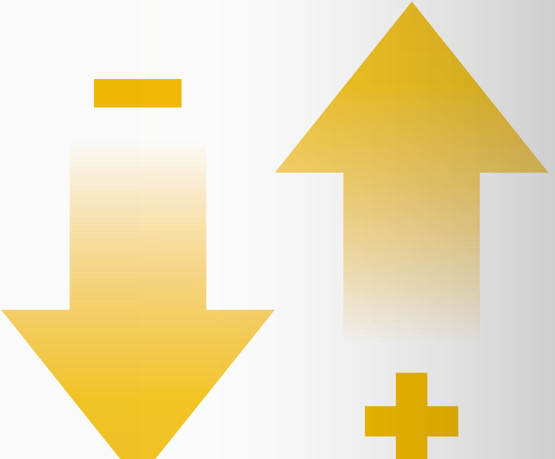
A complementary strategy to improve micronutrient intake

Standards and specifications for fortified rice should specify quality in terms of safety, acceptability (organoleptic and visual), and nutrient content, for the benefit of consumers and manufacturers.

The recently published *WHO guideline: fortification of rice with vitamins and minerals as a public health strategy* supports rice fortification.

Micronutrient levels should be set such that the intake of the micronutrient in the general population, from all sources, is above the estimated average requirement (EAR)[1] and below the tolerable upper limit (UL)[2] for almost everyone.

Where intake is not well known and dietary deficiencies are likely, it is a good approach to set the micronutrient level of fortified rice such that, at prevailing consumption levels, it provides the EAR for adults.



[1] The EAR is the average (median) daily nutrient intake level estimated to meet the needs of half the healthy individuals in a particular age and gender group.
[2] The UL is the daily nutrient intake level that is considered to impose no risk of adverse health effects to almost all (97.5%) healthy individuals in an age- and sex-specific population group.

TABLE 1: Nutrient levels proposed for fortified rice based on average daily rice consumption

Nutrient	Compound	<75 g/d	75–149 g/d	150–300 g/d	>300 g/d	EAR
Iron	Micronized ferric pyrophosphate	12	12	7	7	
	Ferric pyrophosphate with citrate and trisodium citrate, possibly other solubilizing agents [a]	7	7	4	4	
Folic acid (B_9)	Folic acid	0.50	0.26	0.13	0.10	0.192
Cobalamin (B_{12})	Cyanocobalamin	0.004	0.002	0.001	0.0008	0.002
Vitamin A	Vitamin A palmitate	0.59	0.3	0.15	0.1	0.357 (f) 0.429 (m)
Zinc	Zinc oxide	9.5	8	6	5	8.2 (f) 11.7 (m)
Thiamin (B_1)	Thiamin mononitrate	2.0	1.0	0.5	0.35	0.9 (f) 1.0 (m)
Niacin (B_3)	Niacin amide	26	13	7	4	11 (f) 12 (m)
Pyridoxine (B_6)	Pyridoxine hydrochloride	2.4	1.2	0.6	0.4	1.1

[a] Reported effective molar ratio Fe/citrate/trisodium citrate: 1/0.1/2.1.

The above levels are as proposed by WFP and adapted from: de Pee S, Tsang BL, Zimmerman S, Montgomery SJ. Rice Fortification. In: Mannar MGV, Hurrel R, eds. Food Fortification in a Globalized World. London: Elsevier; 2018:131–42. Reproduced from: Scaling Up Rice Fortification in West Africa, 2018.

Two beneficiaries of a WFP school feeding programme

Smiling girls having a school meal in Honduras

Young girl in Myanmar tasting fortified rice

Extruded fortified rice

Simple and affordable technology is now available

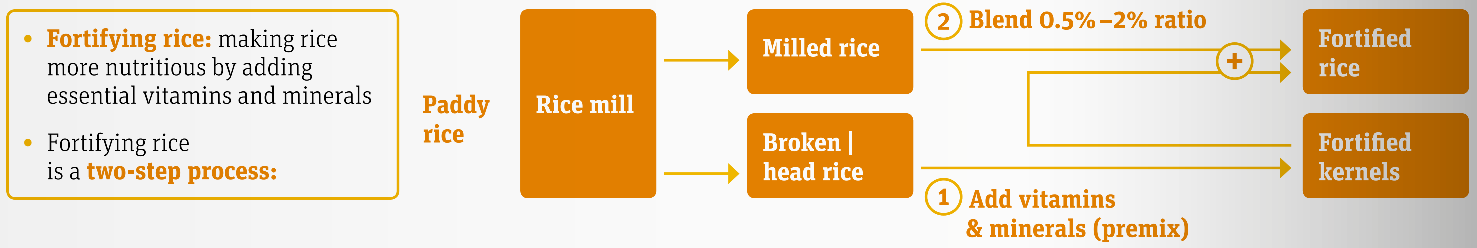
Rice fortification using either extrusion or coating technologies is a two-step process. The first step involves the production of fortified kernels; the second, the blending of fortified kernels with non-fortified rice.

Extrusion and rinse-resistant coating are the best available technologies to produce fortified kernels that remain stable under different storage conditions, preparation methods, and cooking techniques, and that are acceptable to consumers.

Recommended vitamins and minerals to fortify rice include the micronutrients removed during processing, in addition to micronutrients needed to fill the target population's nutrient gaps. Fortification with multiple micronutrients is recommended, as micronutrient deficiencies often coexist.

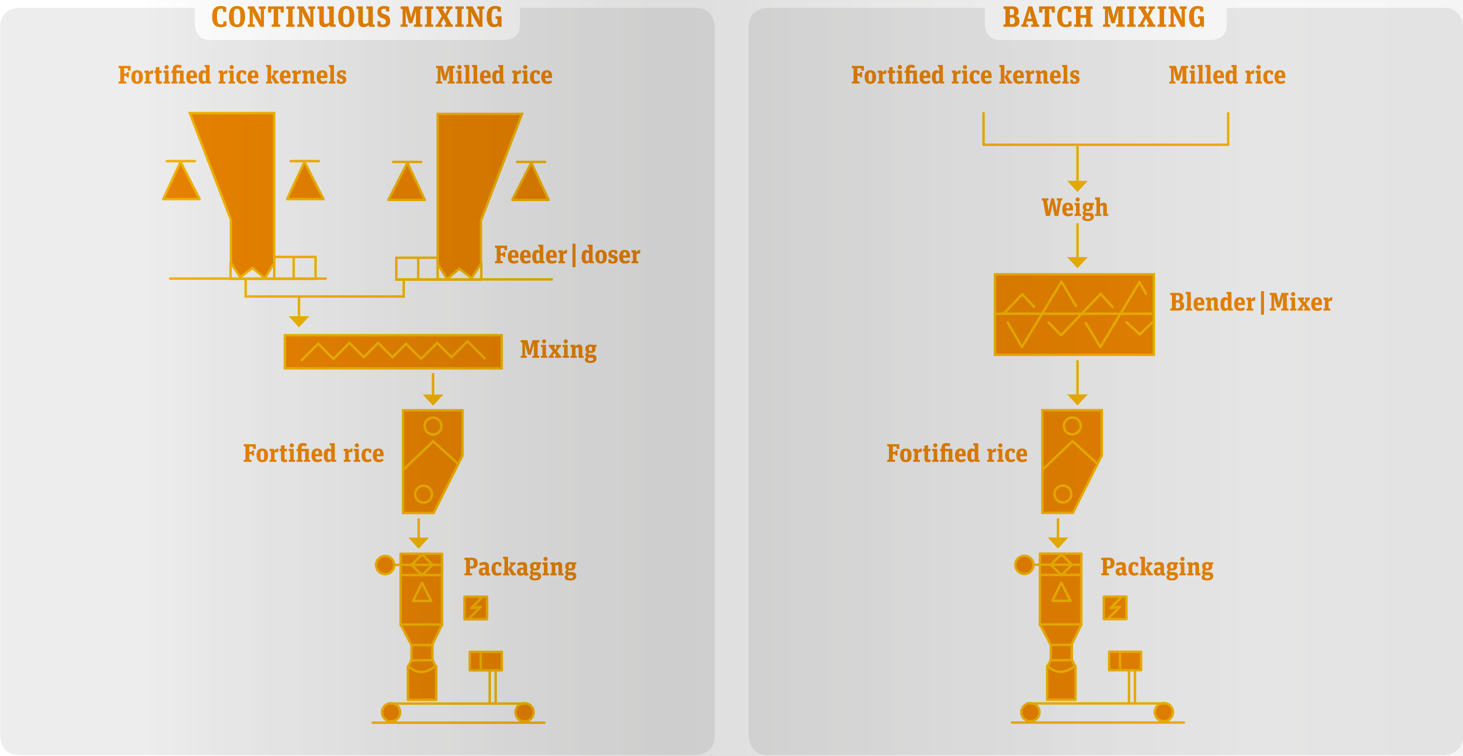
The overall price increase depends on fortification levels, the price of rice (brokens), the blending ratio, and the scale of fortification. In Costa Rica, for example, where almost 100% of the rice is fortified with 7 vitamins and minerals (no iron), the retail price increase is 0.9%. In other countries with voluntary and social safety net fortification, the price increase as a percentage of the retail price is often higher, at 1% to 5% – at least during the initial programming period.

FIGURE 4: Two-step process of rice fortification through coating or extrusion technology



Reproduced from Scaling Up Rice Fortification in Asia, 2015.

FIGURE 5: Production methods for batch and continuous blending to produce fortified rice



For operations at scale, continuous blending is preferred, as it is the more cost-effective solution. Batch blending is more prone to error and more labor-intensive.
Reproduced from Scaling Up Rice Fortification in Asia, 2015.

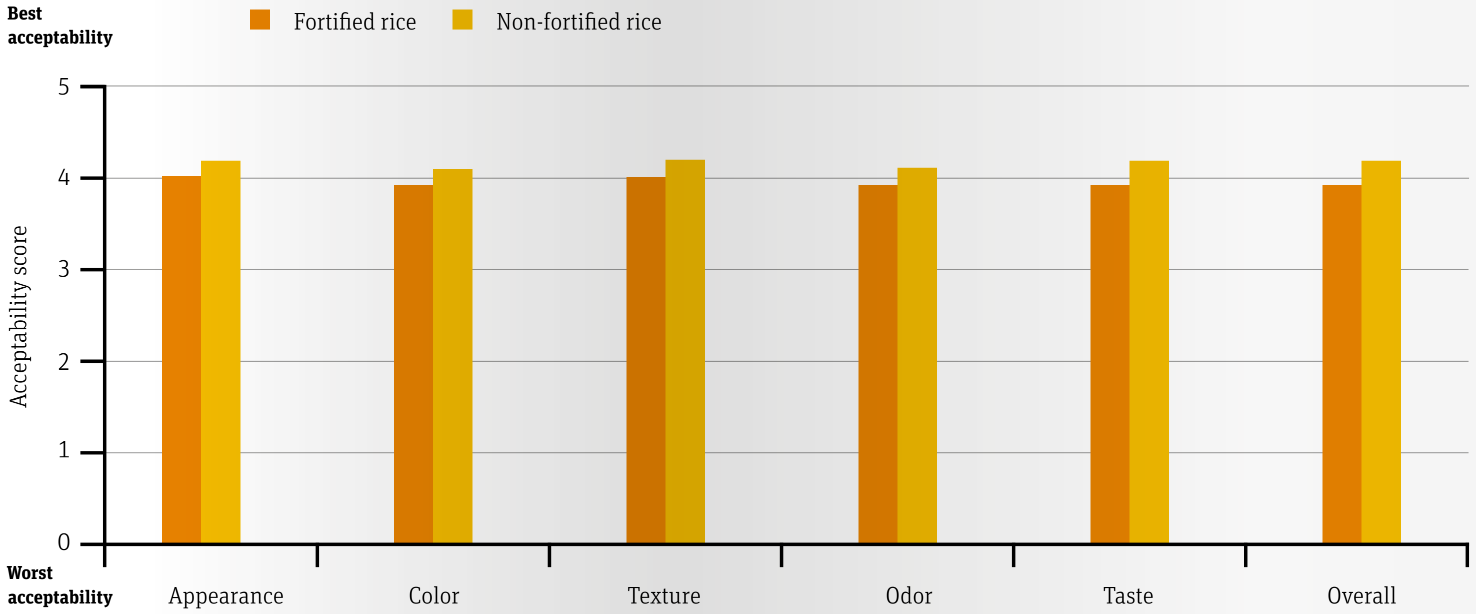
A universally accepted food that benefits populations

Rice fortification is safe. Any variety or type of rice can be fortified. Current technologies can produce fortified rice that tastes, smells, and looks the same as non-fortified rice.

Rice fortification and biofortification differ as to the type, number, and levels of micronutrients in rice and as to when they are included in rice. In biofortification, the process of fortifying occurs during the crop production phase, or prior to the harvest.

In rice fortification, the fortification is done post-harvest and can offer more types and higher levels of micronutrients.

FIGURE 6: Acceptability scores for fortified and non-fortified rice among Indian children aged 8–11 years



The above figures are based on a single acceptability study, which was conducted among children. Other studies conducted among adults (e.g., in Cambodia and Bangladesh) indicate a preference for fortified rice.
Reproduced from: Scaling Up Rice Fortification in Latin America and the Caribbean, 2017.

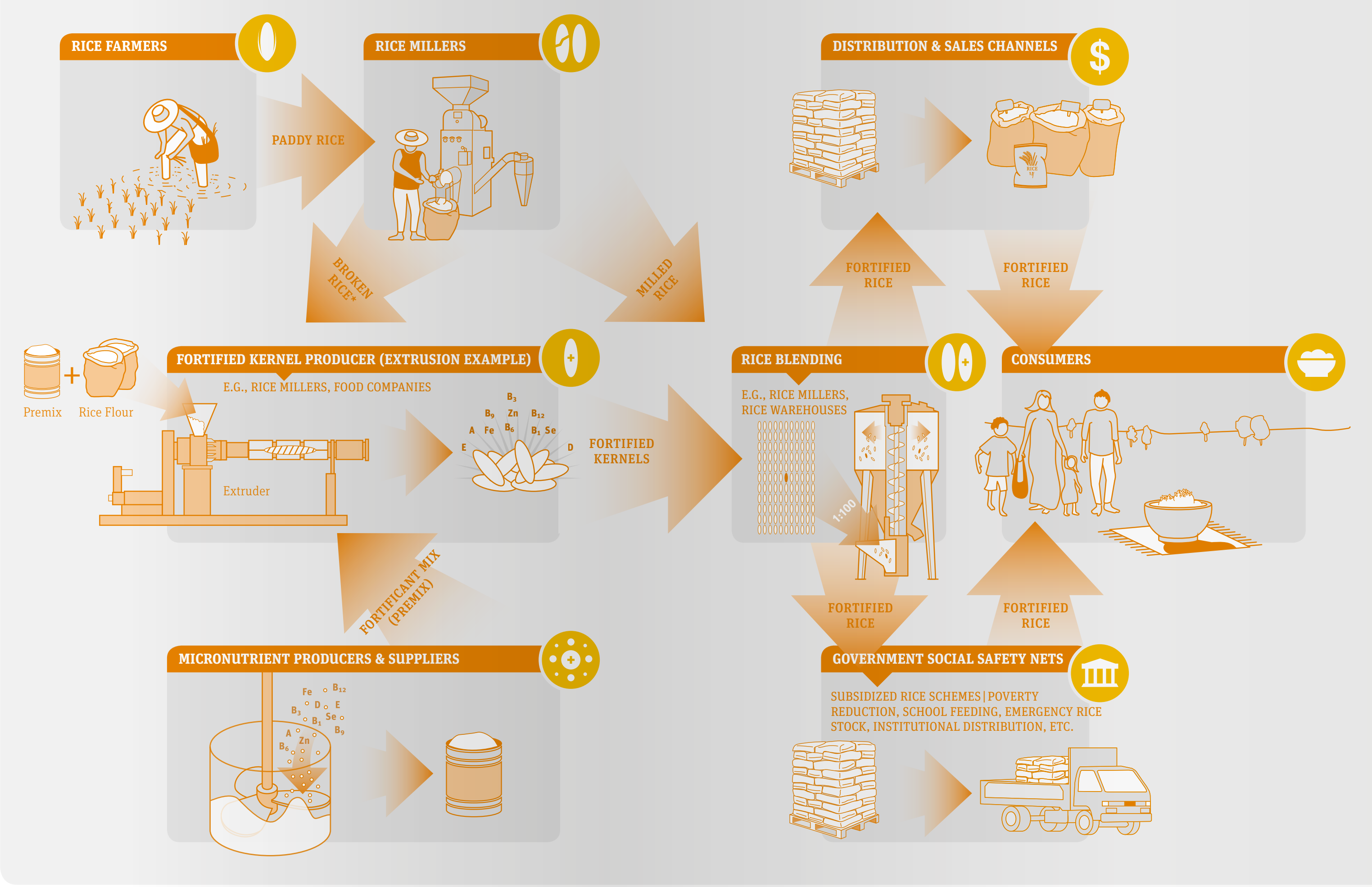
FORTIFIED RICE SUPPLY CHAIN

TERMINOLOGY

Paddy rice: Rice kernels still enclosed in an inedible, protective hull (rough rice).
Head rice: Unbroken grains of milled rice with the hull, bran, and germ removed.
Milled rice: Polished rice is the regular-milled white rice. Hull, bran layer, and germ have been removed.
Blending: Mixing milled, non-fortified rice with fortified kernels in ratios between 0.5% and 2% to produce fortified rice.
Fortificant mix: Blend that contains several selected micronutrients – vitamins and minerals (also referred to as premix).
Fortified kernels: Fortified rice-shaped kernels containing the fortificant mix (extrusion) or whole rice kernels coated with a fortificant mix (coating).

Reproduced from: Scaling Up Rice Fortification in Asia, 2015.

* For extrusion technology broken rice can be used to produce fortified kernels; with coating technology, head rice is required.



Accelerating the global uptake of rice fortification

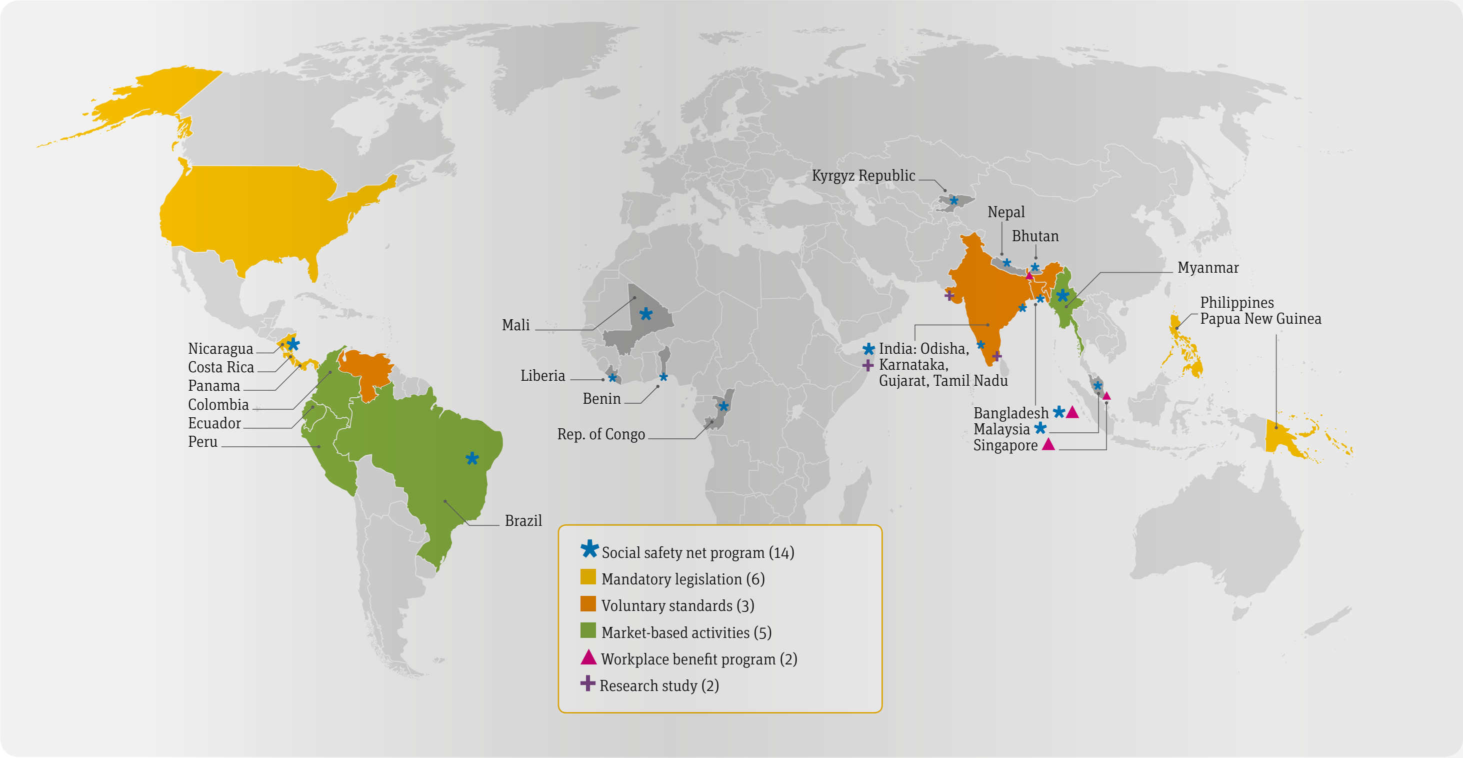
When the rice milling landscape is fragmented and mandatory fortification is not feasible, the fortification of rice distributed through social safety nets is an alternative to achieve public health impact in targeted populations.

Like wheat and maize flour fortification, fortifying rice is a public health opportunity to prevent micronutrient deficiencies and serious birth defects of the brain and spine.

At a national scale, rice fortification is mandatory in six countries, and several subnational efforts indicate that interest in, and the practice of, rice fortification is growing. In comparison, 85 countries globally have mandatory wheat flour fortification legislation.

Fortification of wheat flour with essential vitamins and minerals has been practiced for over half a century; lessons learned in the implementation of wheat flour fortification globally can be applied to rice fortification programs.

FIGURE 7: Global status of rice fortification programs[a]



[a] Does not include research studies involving fortified rice, but includes pilot studies that are intended to demonstrate feasibility of rice fortification (rather than efficacy). Reproduced from: Scaling Up Rice Fortification in West Africa, 2018.

Fortified rice scale-up pathways

Large-scale rice fortification is most successful when driven by a multisectoral coalition, which includes national government, the private sector, and civil society organizations.

Conducting a rice landscape analysis is strongly recommended to determine how to integrate fortified kernel production and blending into the rice supply chain and to assess factors which will influence the potential health impact.

The integration of the additional fortification steps has to take into account the following aspects:

- The structure and capacity of the rice industry
- The complexity of the existing rice supply chain
- The existing distribution channels
- Consumer consumption and purchasing preferences
- Policy and regulatory environment

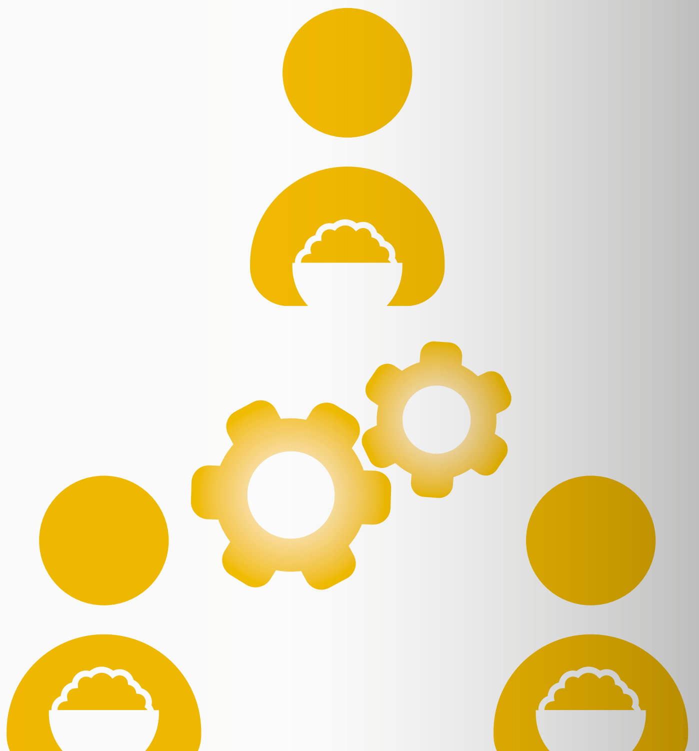


FIGURE 8: Potential public health benefit of different delivery options for fortified rice among vulnerable socioeconomic groups

Delivery option	Low income	High income	Rural	Urban
Voluntary	low	high	low	high
Mandatory	high	high	high	high
Social safety nets	high	low	high	high

Reproduced from: Scaling Up Rice Fortification in Asia, 2015.

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