ZINC-ENRICHED RICE

Improving food and the food system
with a naturally nutritious harvest

HarvestPlus
Better Crops • Better Nutrition

HarvestPlus: Leading a global movement to deliver more-nutritious crops

Thanks to an innovative approach to conventional plant breeding known as biofortification, rice can now be naturally improved to provide higher levels of zinc. It turns this everyday food into a better source of zinc—a micronutrient that is essential for maintaining good health and strong immune systems.

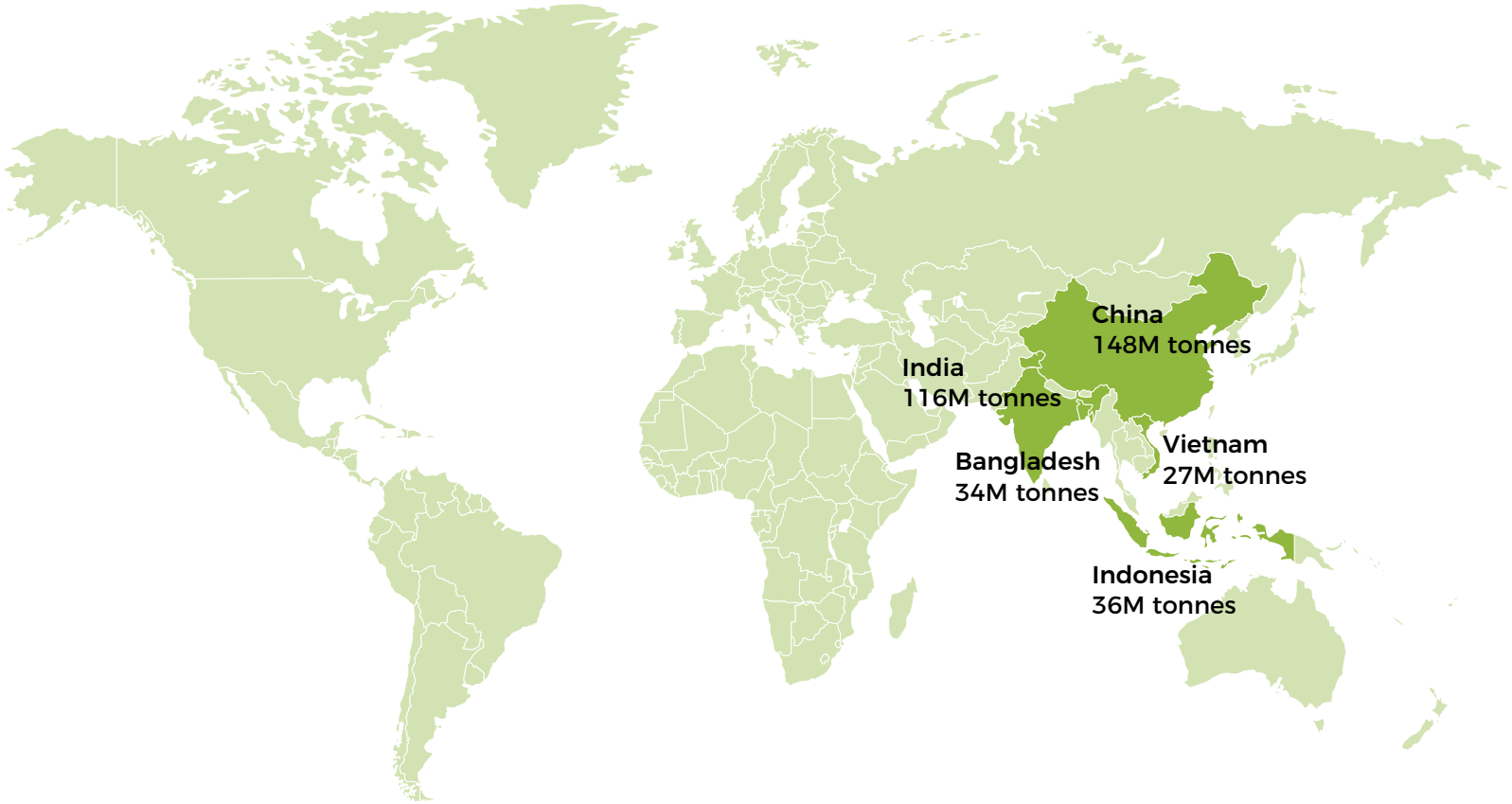
HarvestPlus experts in nutrition, crop development, and agriculture work with partners to unlock genetic variation in rice and develop zinc-rich varieties that can provide malnourished populations with over half of their daily zinc needs when eaten daily. Most currently-grown varieties of rice contain at least 33 percent less zinc compared to biofortified zinc varieties. In some countries, such as Bangladesh, newer varieties of biofortified rice contain 50 percent more zinc than standard varieties.

HarvestPlus is part of the CGIAR global agricultural research partnership and leads a global effort to improve the nutritional value of staple crops. HarvestPlus leverages its CGIAR partners' unrivaled scientific and practical knowledge, skills, and research capacities to respond to the global micronutrient deficiency crisis. In partnership with the International Rice Research Institute (IRRI), several other world leading rice experts, and national agricultural research systems (NARS), we develop and disseminate zinc-rich varieties of rice.

CONSUMERS WANT NATURAL AND ETHICAL NUTRITION

Research shows that consumers want naturally nutritious foods, and zinc is an especially attractive nutrient for consumers because of its role in strengthening immune systems. Consumers also are increasingly motivated to buy products from ethical businesses, and are more likely to buy food from a vendor that cares about nutrition.

LEADING RICE PRODUCING COUNTRIES, 2019



Rice — a globally significant commodity

As a cereal grain, domesticated rice is one of the most widely consumed staple foods globally.

Rice is the seed of the grass species *Oryza sativa var Indica* and *Japonica* (Asian rice), or less commonly, *Oryza glaberrima* (African rice). China and India are the biggest producers, and Bangladesh has the world's highest per-capita consumption (735g per day). Asia accounts for 90 percent of rice consumption globally.

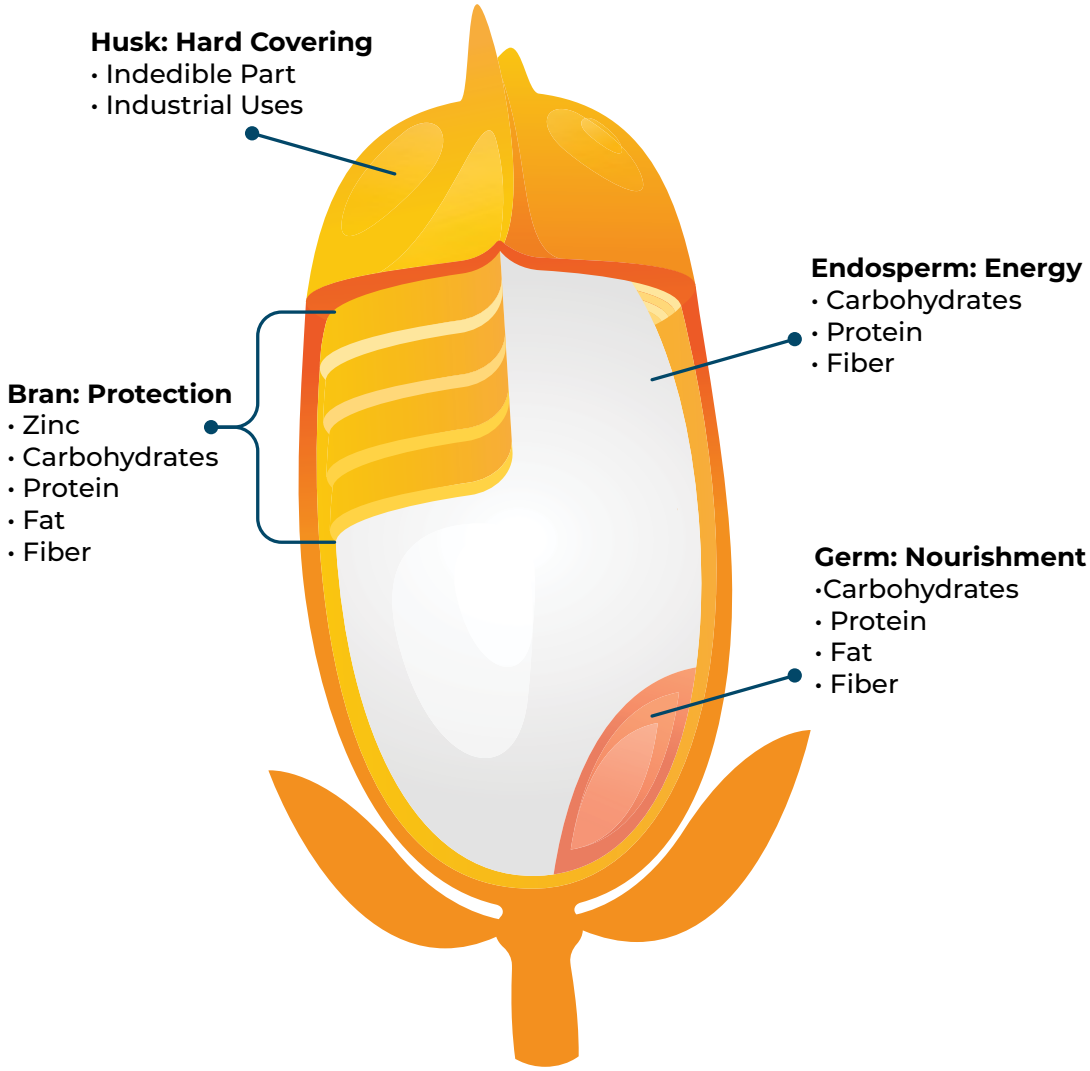
Rice requires special growing conditions; while it is produced over vast areas of the world, the requirements for growing it are specific: a high average daytime temperature but cooler nights during the growing season; a plentiful supply of water applied as needed; and a smooth land surface to facilitate uniform flooding and drainage. Some countries can have two rice crops per year with a rainfed crop and an irrigated crop.

Rice can be short or long grain, basmati (fragrant) or wild rice. Rice is processed to meet local norms, often including polishing to conform to a specific shape and color that consumers demand. The basic commodity is sold raw, dried or parboiled. Parboiled rice needs less cooking time, has better milling yield and can withstand harsher processing conditions (making it attractive for canning or food service), but provides less zinc because the bran has been removed.

For food production and processing, zinc rice is specifically designed to perform the same way as conventional rice. Consumer testing has also shown no perceptible difference in taste or other sensory attributes between zinc rice and conventional rice.

The rice grain

Zinc is mainly stored in the outer bran layers



Global nutrition guidance encourages consumption of whole-grain or brown rice to obtain the full nutritional benefits. When the outer layer of bran is removed from the grain, the mineral and vitamin content in rice is reduced. Yet globally, consumers prefer the overall appearance of white rice, which is readily available in different sizes and shapes, and with varying amylose content (stickiness).

The process of parboiling rice enables up to 18% of bran removal; in countries where parboiled rice is preferred (e.g Banlgadesh) the zinc content is significantly reduced through the full parboiling and milling process. Regardless of the degree of milling or parboiling type, biofortified white rice will contain more zinc to the non biofortified standard type.

Zinc and the prevalence of zinc deficiency

Micronutrients are vitamins and minerals such as vitamin A, zinc, and iron. Although micronutrients are only required by the body in very small amounts, they are essential to maintaining good health, preventing illness, and ensuring children's proper development and growth.

More than 2 billion people around the world suffer from micronutrient deficiency, which is also known as "hidden hunger." The name refers to the fact that symptoms of micronutrient deficiency may not be easy to see but can have a detrimental lifelong impact, such as impairment of mental capacities, lower resistance to disease, and fatigue.

The diets of lower-income consumers in low- and middle-income countries usually consist of relatively larger amounts of staple foods (such as wheat, corn, and rice) and fewer micronutrient-rich foods such as fruits, vegetables, and animal-source foods. These diets therefore do not contain enough zinc to maintain health, and zinc deficiency is one of the biggest contributors to hidden hunger globally.

Around 17 percent of the global population are at risk of inadequate zinc intake. The prevalence of zinc deficiency is estimated to exceed 25 percent of the population in sub-Saharan Africa and 29 percent in South Asia. Since zinc deficiency is a contributor to stunting (low height for age), stunting is commonly used as a proxy to estimate the risk of zinc deficiency in a population.

Zinc is involved in more bodily functions than any other mineral. It is essential to more than 200 enzyme systems, normal growth and development, the maintenance of body tissues, reproductive health, vision, and the immune system. Zinc is vital for survival, meaning its deficiency has serious consequences for health, particularly during childhood when zinc requirements are higher. In addition to stunting, zinc deficiency can increase the risk of common and potentially deadly childhood infections, including diarrhea, pneumonia, and malaria.

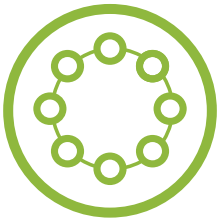
- **Asia is heavily dependent on rice. It is the basic staple for most of the population, including the region's 560 million low-income residents.** While it provides up to 70 percent of the energy intake in some Asian countries, it is a poor source of micronutrients. Biofortification and the use of zinc rice can change this.
- **HarvestPlus-Bangladesh started zinc rice delivery activities in 2013.** HarvestPlus aims to improve zinc nutrition status, especially among women and children, through zinc-biofortified rice production and consumption.
- **Average rice consumption in Indonesia is approximately 285 grams per day.**

New Research Evidence in 2022: Eating zinc-biofortified rice improved the growth of Bangladeshi preschool children who ate it every day for nine months, compared to children who ate traditional rice for the same duration in a randomized, controlled study published in the *American Journal of Clinical Nutrition*. Optimizing linear growth has lifelong physical and cognitive benefits.

Why do we need zinc? Authorized nutrient function claims

Zinc is needed for hundreds of body processes. Below are the generally accepted benefits that can be stated on food packaging when the food meets the local requirements of "source of" or "high in."

Contributes to normal cognitive function



Contributes to normal fertility and reproduction

Contributes to the normal functioning of the immune system

Contributes to the maintenance of normal bones

Contributes to normal carbohydrate, fat, and protein metabolism

Contributes to the maintenance of normal skin, hair and nails

Contributes to the maintenance of normal vision

Zinc and immunity

The immune system is particularly sensitive to zinc status, yet the body does not store zinc, so regular intake is required. When someone is zinc-deficient, this generally manifests as poor growth and increased risk of infection.

Zinc rice provides consistent access to this micronutrient that is essential to sustaining health, optimizing immune function, and reducing the risk or severity of illnesses. COVID-19 and other viruses challenge the immune system; a good diet that includes zinc is required to optimize the body's response to illness.

Ways to improve foods, food systems, and diets

Consumers can increase their dietary zinc intake by taking supplements when they have no access to foods that are good zinc sources (e.g., red meat and poultry, beans, nuts, seafood, whole grains, fortified breakfast cereals, and dairy products).

Many countries have laws or policies to promote use of post-harvest, industrial fortification to add zinc to flour and other foods, but these are rarely enforced. In general, the use of fortification has increased over the last 10 years, though only 1 percent of industrially milled rice is fortified, and rice is one of the most difficult staples to fortify due to the individual rice kernels. The process of fortifying foods with zinc can also be technically challenging, adding complexity in the supply chain. At times, demand for milled rice is so high that there is no time to conduct the fortification process. Biofortified zinc rice helps fill gaps where fortified products are not feasible or cannot reach certain groups of people.

Market trends in some countries show that consumers prefer foods that contain natural sources of vitamins and minerals, not additional ingredients on the label. Consumers are seeking "cleaner" food labels and foods with fewer added ingredients. With biofortification, there are no special labelling provisions required.

Where does zinc come from?

Dietary sources high in zinc include red meat and poultry, beans, nuts, seafood, whole grains, fortified breakfast cereals, and dairy products. Zinc is abundant in the soil, and some plants and animals can take it from the soil more easily than others. There are also zinc-fortified foods and supplements.

Why is there so much zinc deficiency?

Animal-source or fortified foods may not be widely available or consumed in rural and resource-constrained households. Absorption of zinc from plant-based and whole grain foods is also limited by the presence of relatively high plant content of a food fiber known as phytate, which is important for plant health, among other things. Staple crops are sometimes excessively refined, when the bran layer is removed this removes most of the zinc.

How much zinc do we need?

As a guide, the recommended daily intake for zinc is 10 milligrams; this is a general guideline used for product labelling. Other references exist, and governments often have a population-specific set target.

Can I have too much zinc?

There is no risk that consumption of zinc-rich rice products will increase a person's zinc intake above the safe upper limit.

Zinc rice has value throughout the value chain

The varieties of zinc rice promoted by HarvestPlus are a pioneering breakthrough that will be part of the solution to one of the world's biggest problems of malnutrition in low- and middle-income countries, and will also respond to increasing consumer demand for naturally nutritious foods worldwide.

For Rice Farmers

- I want to grow a variety that we can eat as a family and is good for us.
- I want to grow varieties that are in demand.
- I need varieties that are high yielding, cost efficient, and easy to grow, so I get a good price.
- I want a variety that is high yielding and rust resistant.

For Food Manufacturers and Retailers

- Zinc rice brings innovation to a product category that hasn't seen innovations or growth for many years.
- I want to be ahead of the competition with the latest innovation in food systems.
- I want to invest in foods that are not only good for profits and good for consumers, butare good for the world.
- Social responsibility is good for business.

For Consumers

- I want a naturally more-nutritious version of the food I commonly consume.
- I want to buy healthy foods with fewer added ingredients.
- I want to buy foods that are interesting and good for me.
- I want to buy foods that are good for the world, and good for the planet.
- I care about where my food comes from.

> "I am happy providing not only rice but nutritious zinc rice to consumers across the country. There is a huge demand for zinc rice in the market."
>
> — Muhammad Motaher Hossen Monir, Rice Mill Owner, Bangladesh

Rice Nutrition

HarvestPlus has developed labeling guidelines for many countries to demonstrate how to communicate nutrition and health claims for zinc-rich rice to consumers. It is possible to make nutrition content claims and nutrition function claims in compliance with local legislation. For example, depending on the food format and country, a product could carry the following claims:

- Natural source of zinc
- Zinc is essential for a healthy immune system

Part of a healthy diet

Whole-grain rice is recognized as a base for a healthy diet.

Phytochemicals

Evidence is emerging that, in addition to fiber and minerals, the unique phytochemicals in whole-grain rice may in part contribute to health-promoting effects.

Gluten free

If kept separate from other gluten grains in the supply chain, rice is a gluten free alternative.

High in fiber

Whole-grain rice is a good source of fiber. Brown or wholegrain rice has a lower glycemic index than white rice.

Table 1. Nutrition information for rice

Values per 100g	Biofortified Zinc Rice minimum Target	USDA – Rice, white, short-grain, raw
Calories	353	358
Protein (g)	9.7	6.5
Carbohydrates, by diff. (g)	76	79.2
Sugar (g)	4	4
Fat (g)	0.5	0.5
Saturated Fat (g)	0.2	0.2
Fibre (g)	3	3
Sodium (mg)	0.2 mg	0.2mg
Zinc (mg)	2.2	1.1

In some cases, zinc rice can contain more than twice the level of zinc found in the standard variety and the levels are getting higher with each new crop variety developed. Values are for raw milled (polished) rice which has not been parboiled.

Standards for levels of zinc in rice are published

There are clear food labelling provisions applicable to zinc rice as a food, but up until recently, there were no standards for grain procurement. Now buyers can demand zinc rice at the commodity level for public procurement or as a raw material for food processing.

Ask your suppliers for zinc-rich rice. Use the newly published Publicly Available Standard, number 233. The tables below are from the Publicly Available Specification for zinc-biofortified grains, showing the levels of zinc required in order to be designated as zinc rice.

Table 2. Levels of zinc concentration in zinc enriched husked brown rice

Class	Zinc concentration mg/kg	Standard method of analysis (or equivalent)
Class I	≥ 36	AOAC 999.10 [N1]
Class II	33.0 – <36	
Class III	30.0 – <33	

Table 3. Levels of zinc concentration in zinc enriched milled rice*

Class	Zinc concentration mg/kg	Standard method of analysis (or equivalent)
Class I	≥ 28	AOAC 999.10 [N1]
Class II	25.0 – <28	
Class III	22.0 – <25	

* not applicable to parboiled rice

How does zinc rice compare to common rice?

The amount of zinc in standard rice varies throughout the world and is highly dependent on environmental conditions. However, the zinc content of biofortified varieties are consistently higher than non-biofortified rice varieties in most environments. The zinc content in biofortified zinc rice is up to 75 percent higher than non-biofortified varieties.

Apart from zinc and iron content, zinc rice has the same or very similar nutritional parameters as conventional rice, which means no differences in food processing and taste tests.

Product innovation and renovation with zinc rice

The rice and rice flour product market has never before seen nutrition innovation! This is big news for a stable growth, low-cost commodity. Here are some examples where zinc rice can help you and your business with new product innovation.

How can you get zinc rice into your product portfolio?

Build supply chains with HarvestPlus. With our crop research partners, we have developed 21 varieties of zinc rice that have been officially released for production in eight countries, and which are adapted to numerous growing regions and climates. We can work with you to find a variety that suits your particular needs.

In our work with smallholder farmers, zinc rice is a major crop for the HarvestPlus program. It is a rich source of nutrition for low-income smallholder farming families who also depend on rice as a source of income. HarvestPlus has many years of experience working with rice.

Depending on your location and the type and volume of rice you are interested in, we can help you find the right rice to grow in the right climate. HarvestPlus can enable supply chains for you and your business. Using this route, you will be providing market access for the world's most vulnerable smallholders.

However, we know that in switching to more-nutritious rice, it is not always possible to work with smallholders; you may already be working with leading growers and have a strong and dependable supply chain of producers. In this case, we can work with you and your growers to switch over your current rice varieties to a zinc rice variety. The expert plant breeders, agronomists, and food technologists at HarvestPlus will help at every step of the way. This work provides a revenue stream for our nonprofit organization and, crucially, brings in investment and awareness of the malnutrition problem and food-based solution. We have several services available to assist with your transition to naturally nutritious zinc enriched rice.

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