



IRON PEARL MILLET

Improving food and the food system
with a naturally nutritious harvest







HarvestPlus: Leading a global movement to deliver more nutritious crops

Thanks to an innovative approach to crop breeding known as biofortification, pearl millet is now naturally improved to provide higher levels of iron. Biofortification turns pearl millet into a better food source of iron, a micronutrient that is essential for maintaining good brain and body health. The currently available nutrient-enriched varieties have been developed through conventional breeding techniques.

HarvestPlus experts in nutrition, crop development, and agriculture work with partners to unlock genetic variation in pearl millet and develop iron pearl millet varieties that can provide malnourished populations with up to 75 percent of their iron needs when eaten daily as their primary staple food. Biofortified varieties contain at least 30 percent more iron than most currently-grown conventional 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' scientific and practical knowledge, skills, and research capacities to respond to the global micronutrient deficiency crisis. In partnership with the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), several other world-leading millet experts, and national agricultural research systems (NARS), HarvestPlus develops, disseminates and commercializes iron pearl millet seeds, grains, and foods.

CONSUMERS WANT NATURAL AND ETHICAL NUTRITION

Research shows that consumers want naturally nutritious foods, and iron is an especially attractive nutrient for consumers because of its role in strength, energy, and pregnancy, as well as mental development and learning capacity during childhood. Consumers are also increasingly motivated to buy products from ethical businesses and are more likely to buy food from a vendor that cares about nutrition.

What is pearl millet?

Millet is a cereal grain of the Poaceae family, more commonly known as the grass family. There are several types of millets, including foxtail, proso, finger, kodo, little, and pearl. Outside of India and regions of Africa, consumers may not be familiar with millet. Pearl millet is the most widely produced type for human consumption, though all types are renowned for their regional adaptation, high nutritional value, and health benefits. In addition to iron, pearl millet is also a good source of calcium, zinc, and magnesium.



GLOBAL MILLET PRODUCTION



Pearl millet — a globally significant commodity

As a cereal grain, domesticated pearl millet is a commonly consumed staple food for more than 90 million people, particularly in India and Africa, and an emerging novel grain in many other countries where millets do not have a long history. Iron pearl millet is gluten-free, has a low glycemic index, and is climate-smart.

Pearl millet—the most common type of millet—is also known as *bajra* in Hindi, *sajje* in Kannada, *kambu* in Tamil, *bajeer* in Kumaoni and *maiwa* in Hausa. It has been grown since prehistoric times in Africa (from roughly 4,800 years ago, especially in the Sahel and West Africa) and the Indian subcontinent.

Pearl millet is hardy and will grow where other staples such as maize or wheat will not survive.

It is adapted to grow in drought conditions, poor soils (high salinity and low pH), and high temperatures. Pearl millet is a summer annual crop well-suited for double cropping and rotations.

Pearl millet is generally found as a whole grain, with the individual kernels (pearls) ground to make flour. It is most commonly consumed as a flatbread or a porridge but is increasingly used in product innovation in foods such as breakfast cereals, cookies, noodles, and infant foods. Due to the presence of polyunsaturated (healthy) oils, the shelf life of the flour is short, however, it can be extended through the use of heat treatments and/or antioxidants (such as vitamin E or rosemary extract).



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

Today, pearl millet is grown on over 260,000 square kilometers of land worldwide. It accounts for about 50 percent of the total world production of millets.

India, Niger, and China are the largest producers of millets in the world, accounting for more than 55 percent of global production. For many years, India was the world's major producer of millet. However, in recent years, millet production has increased significantly in and Africa.

According to the Food and Agriculture Organisation, world millet production was estimated at 28.2 million metric tons in 2019 and 30.5 million metric tons in

2020. India is the largest global producer, with a 33.3 percent global millet market share in 2020. In the last two decades, the importance of millet as a food staple, particularly in India, has been declining due to various factors, including rising incomes, growing urbanization, and government policies. More than 50 percent of millet production is currently finding its way into alternative uses as opposed to its consumption only as a staple.

A climate-smart crop

This ancient cereal has been recognized for its climate-resilient characteristics, including ability to grow on arid lands with minimal inputs. Millets are suitable for cultivation under adverse, changing climatic conditions.

Iron pearl millet has the potential to improve global nutritional insecurity and become a sustainable alternative to major staples for the growing population amid climate change.

Why do we need iron? Authorized nutrient function claims

Iron 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” iron.



Contributes to normal cognitive function



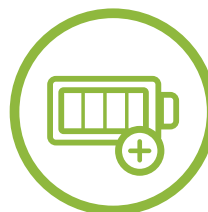
Contributes to normal physical work performance



Contributes to normal oxygen transport in the body



Contributes to normal function of the immune system



Reduces tiredness and fatigue

Iron deficiency

Globally, iron deficiency is the most prevalent malnutrition disorder, particularly among children and women of reproductive age.

Many countries have adopted industrial fortification programs to address this deficiency by increasing the micronutrient content of specific foods.

Fortification is a proven, effective intervention to reduce iron deficiency. However, it only works well when it is applied to commonly consumed foods and the intended consumers can access these foods consistently.

How much iron do we need?

The optimum amount of iron our bodies need to stay healthy varies by sex, age group, and population. In general, women of reproductive age need relatively more iron than other population segments, and women's iron needs significantly increase during pregnancy.

As a guide for consumers, an intake of 14 milligrams per day is recommended for food labelling purposes.

Why don't we get enough iron from our food?

The best dietary sources of iron are red meat, liver, poultry, and fish. However, these foods are often less affordable or not available in low-income, rural food systems and may not be culturally accepted. In many countries and cultures, religious beliefs do not allow consumption of specific meats, or they are prioritized for male members of the household. In addition, many consumers in more-affluent countries are choosing to eliminate or reduce meat consumption for ethical, environmental, or health reasons.

Several staple crops and vegetables are good sources of iron such as leafy greens, pulses, nuts, and whole grains. Although absorption of iron from plant foods is lower than iron from animal foods, studies show that the added dietary iron from iron pearl millet makes a difference to health.

Ways to improve foods, food systems, and diets

Many countries have laws or policies to promote use of post-harvest, industrial fortification to add iron to flour and other foods, but they are rarely enforced. The process of fortifying foods with iron can be technically challenging, adding complexity in the supply chain. Iron pearl millet can help fill the gap 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. Consumers are seeking “cleaner” food labels and foods with fewer added ingredients on the label. With biofortified foods, no special labelling provisions or additional ingredients are required.



Iron pearl millet in India

The HarvestPlus India program started iron pearl millet commercialization activities in 2013.

A study conducted in India has shown that eating iron-biofortified pearl millet measurably improves brain function and cognitive behaviors like memory and attention, in addition to increasing iron levels in the body.

International Year of Millets

The United Nations General Assembly adopted a resolution, sponsored by India and supported by more than 70 countries, declaring 2023 as the International Year of Millets. The declaration is intended to increase public awareness of the nutrition and health benefits of millets and their suitability for cultivation under tough conditions marked by climate change.

Iron pearl millet benefits for actors across the value chain

Varieties of iron pearl millet promoted by HarvestPlus are a pioneering breakthrough that will be part of the solution to one of the world's biggest problems of malnutrition, and will also respond to increasing consumer demand for naturally nutritious foods worldwide.



Pearl Millet Farmers

- I want to grow a variety that we can eat as a family and is good for us.
- I am worried about climate change and want to grow crops that are more resistant to the changing climate.
- I want to grow varieties that are in demand.
- I need varieties with high yield, that are cost efficient, and are easy to grow so I get a good price.
- I also use millet as food for my animals because this variety is also healthy for my livestock.



Food Manufacturers and Retailers

- Iron pearl millet is seen by consumers as a super food as it has so many nutrition, health and environmental benefits.
- 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, but are good for the world. Social responsibility is good for business.
- I already have a solid and reliable supply chain, so I don't want to pay more or disrupt my current business activities.



Consumers

- I want to try new foods and new grains.
- I want a naturally more-nutritious version of the food I commonly consume.
- I want to buy healthy foods with less 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.



A great innovation by HarvestPlus, iron pearl millet helps promote a healthy way of life for all, especially women and children, by alleviating hidden hunger. HarvestPlus' expertise enabled MicroNutrich Private Limited to capitalize upon the untapped market for iron pearl millet by offering naturally enriched products to address the prevailing micronutrient deficit globally."

— Yuvaraj Kasa, Kirti Danwar, and Saravanan Shanmugam
Founders of MicroNutrich Private Limited, India

IRON PEARL MILLET NUTRITION

HarvestPlus has developed labeling guidelines for many countries to demonstrate how to communicate nutrition and health claims for iron pearl millet to consumers. Nutrition content claims and nutrition functional claims can be made in compliance with local legislation. For example, depending on the food format and country, a product could carry the following claims:

- Natural source of iron
- Iron is essential for prevention of anemia

Part of a healthy diet

Millets are recognized as a base for a healthy diet, and a source of calcium, zinc and magnesium.

High in fiber

Iron pearl millet is a good source of fiber and has a low glycemic index.



Gluten free

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

High in protein

Iron pearl millet is a source of protein and has a higher protein content than other cereals, making it an alternative source of protein for meat free foods.

Low in saturated fat

Iron pearl millet is a source of healthy polyunsaturated omega 3 fatty acids.

A natural source of iron

Iron pearl millet contains iron that is proven to be bioavailable in several human studies.

Nutrition evidence

When eaten daily, iron pearl millet is proven to resolve iron deficiency in adolescent children, improve cognitive measures such as memory and attention, and improve levels of physical activity.

Table 1. Nutrition information for iron pearl millet

Values per 100g	Iron Pearl Millet (Minimum Levels)
Calories	375 g
Protein	11.4 g
Carbohydrates, by diff.	67 g
Sugar	3 g
Fat	5.6 g
Saturated Fat	0.2 g
Fiber	5.5 g
Sodium	0.2 mg
Iron	7.7 g

Standards for levels of iron in pearl millet: the Publicly Available Specification

Clear food labelling provisions are applicable to iron pearl millet as a food, but until recently, there were no standards for pearl millet grain procurement.

Buyers can now demand iron pearl millet at the commodity level for public procurement or as a raw material for food processing. Table 2 is from the Publicly Available Specification (PAS) 234 and shows the levels of iron required in a variety to be designated iron pearl millet.

How does PAS 234 relate to local regulation?

PAS 234 applies to all countries in the world that grow, and all businesses (no matter their size) that produce or procure, pearl millet grains for human consumption. It is intended to be used in support of, or alongside, local rules and regulations.

Is there variation in iron levels between grains?

Setting global standards and minimum levels for iron content can be difficult due to variations in the environmental conditions. When judging nutrient values of a finished grain, a benchmark standard will be required to ascertain a genuine increase in nutrition compared to conventional, standard varieties.

All crops have natural variation in their iron content. If soil is highly deficient in iron or generally poor quality, the edible grain of the plant will not contain optimum levels of iron. Under such circumstances, biofortified varieties may not reach the minimum levels required to be considered class 1 accordingly to the PAS; nonetheless, the biofortified grain will still be higher in iron compared to standard varieties.

Table 2. Levels of iron content in iron enriched pearl millet

Class	Iron content mg/kg	Standard method of analysis (or equivalent)
Class I	≥ 77	AOAC 999.10
Class II	69 – <77	
Class III	62 – <69	

Note: Class I provides the highest nutrition impact when consumed as a whole grain minimally processed food. Iron enriched pearl millet should be produced using optimal agricultural conditions and agronomic practices to achieve the highest iron content.

How does iron pearl millet compare to common millet?

The amount of iron in conventional pearl millet varies throughout the world. However, the iron content of biofortified pearl millet is at least 30 percent higher than conventional pearl millet, and up to 75 percent higher in some varieties.

The iron in iron pearl millet is also more bioavailable and well absorbed by the body.

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



Product innovation and
renovation with iron pearl millet





How can you get iron pearl millet into your product portfolio?

Build supply chains with HarvestPlus

With our partners, HarvestPlus has developed 21 varieties of iron pearl millet 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, iron pearl millet 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 pearl millet as a source of income. HarvestPlus as part of the CGIAR has many years of experience working with millets.

Depending on your location and the type and volume of pearl millet you are interested in, we can help you find the right pearl millet 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 millet, 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 varieties to an iron pearl millet 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 about malnutrition and food-based solutions. We have several services available to assist with your transition to naturally nutritious iron pearl millet.

Demand iron pearl millet

Ask your suppliers for iron pearl millet. Use the newly published Publicly Available Standard 234. Contact HarvestPlus for advice and help to source quality seeds with a variety that qualifies as genuine iron pearl millet.



Get in touch! For more information please [contact us.](#) | [FACEBOOK](#) | [LINKEDIN](#) | [HARVESTPLUS.ORG](#)