



Millets as Future Food: A Sustainable Solution for Global Nutrition and Food Security

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The global food system faces significant challenges, including feeding an estimated 9.7 billion people by 2050, addressing malnutrition, and mitigating the impacts of climate change. Millets, a group of small-seeded grasses cultivated for thousands of years in Asia and Africa, have emerged as a promising solution to these challenges. With their exceptional nutritional profile, resilience to harsh environmental conditions, and low resource requirements, millets have the potential to contribute significantly to global nutrition and food security. This article explores the multifaceted role of millets as future food, highlighting their nutritional benefits, environmental sustainability, and socio-economic importance.

The Nutritional Powerhouse of Millets

Millets are renowned for their rich nutritional content, offering a balance of macronutrients, micronutrients, and bioactive compounds essential for human health.

Macronutrients

Complex Carbohydrates: Millets are a rich source of complex carbohydrates, providing steady and sustained energy release. Unlike simple carbohydrates, the complex carbohydrates in millets have a low glycemic index, contributing to better blood sugar control. For instance, foxtail millet has a glycemic index significantly lower than that of rice and wheat, making it suitable for individuals managing blood sugar levels.

Proteins: Containing higher protein content compared to other major cereals like rice and maize, millets range from 9% to 13% protein, depending on the variety. They possess a unique amino acid profile, with a higher proportion of essential amino acids such as methionine and cysteine, which are often limited in plant-based diets.

Dietary Fiber: High in both soluble and insoluble dietary fibers, millets aid in digestion, promote gut health, and help prevent gastrointestinal disorders. Finger millet, for example, contains up to 15% dietary fiber, significantly higher than common cereals. This high fiber content contributes to prolonged satiety and improved digestive function.

Micronutrients

Vitamins: Millets are a good source of B-vitamins, including niacin (B3), thiamine (B1), and riboflavin (B2), which play crucial roles in energy metabolism and neurological function. Pearl millet contains a substantial amount of niacin per 100 grams, contributing significantly to daily nutritional requirements.

Minerals: Millets are rich in essential minerals:

- **Iron:** Critical for hemoglobin formation, finger millet contains a notable amount of iron per 100 grams, helping to prevent anemia.
- **Calcium:** Vital for bone health, finger millet provides a high calcium content, the highest among cereals.
- **Magnesium and Phosphorus:** Important for bone development and energy metabolism, supporting overall physiological functions.

Bioactive Compounds: Abundant in antioxidants such as phenolics and flavonoids, millets have been linked to reduced risks of chronic diseases, including cardiovascular diseases, diabetes, and certain cancers. These bioactive compounds help combat oxidative stress and inflammation in the body.

Environmental Sustainability of Millets

Climate Resilience: Millets are often referred to as "climate-smart" crops due to their ability to withstand harsh environmental conditions.

Drought Tolerance: Requiring significantly less water compared to other staple crops, millets like pearl millet need about 350-400 mm of water per season, whereas rice requires much more. This makes millets suitable for cultivation in arid and semi-arid regions, contributing to agricultural sustainability in water-scarce areas.

Heat Resistance: Thriving in temperatures ranging from 25°C to 35°C, with some varieties tolerating even higher temperatures, millets are adaptable to regions experiencing increased temperatures due to climate change. Their resilience makes them a reliable crop under varying climatic conditions.

Short Growing Season: Some millet varieties mature in as little as 65 days, allowing for multiple cropping cycles and enhancing food production. This short growing season enables farmers to optimize land use and increase yield.

Low Input Requirements

Soil Fertility: Capable of growing in poor and marginal soils with minimal fertilizer inputs, millets are efficient in nutrient uptake and can thrive in a range of soil pH levels. This reduces dependency on chemical fertilizers, lowering costs and minimizing environmental impact.

Pest and Disease Resistance: Exhibiting natural resistance to many pests and diseases, millets reduce the need for pesticides. This characteristic is beneficial for smallholder farmers who may lack access to or cannot afford agrochemicals.

Carbon Footprint: Due to their low input requirements and minimal need for irrigation and agrochemicals, millets have a lower carbon footprint compared to other cereals. Promoting millet cultivation aligns with global efforts to reduce greenhouse gas emissions from agriculture.

Millets and Global Food Security

Diversification of Food Sources: The global food supply heavily depends on a few staple crops, increasing vulnerability to pests, diseases, and climate impacts. Incorporating millets enhances agrobiodiversity, contributing to resilience against crop failures and promoting a more secure food system.

Addressing Malnutrition: Millets can combat malnutrition and micronutrient deficiencies, especially in developing countries. Their rich nutrient profile helps alleviate "hidden hunger" caused by insufficient intake of essential vitamins and minerals. Iron-rich millets, for example, can reduce the prevalence of iron-deficiency anemia affecting millions worldwide.

Economic Empowerment

Smallholder Farmers: Often grown by smallholder farmers in rural areas, promoting millet cultivation can improve livelihoods by providing a reliable income source and enhancing

household food security. Millets offer an opportunity for these farmers to cultivate crops suitable to their local conditions.

Market Opportunities: The growing demand for healthy and sustainable food products opens new markets for millet-based products. This stimulates rural economies and encourages the development of value chains around millets, from production to processing and marketing.

Health Benefits of Millets

Diabetes Management: With a low glycemic index, millets help in the slow release of glucose into the bloodstream, preventing sudden spikes in blood sugar levels. Studies have shown that substituting rice with millets can improve glycemic control in individuals with type 2 diabetes, making them a valuable dietary component for managing this condition.

Cardiovascular Health

Millets contribute to heart health through:

- **Cholesterol Reduction:** Soluble fiber in millets binds to bile acids, promoting their excretion and lowering cholesterol levels.
- **Blood Pressure Regulation:** The magnesium and potassium content in millets helps regulate blood pressure, reducing the risk of hypertension.

Digestive Health: The high fiber content enhances bowel movement, prevents constipation, and supports a healthy gut microbiome. Millets also act as prebiotics, fostering the growth of beneficial gut bacteria.

Antioxidant Properties: Antioxidants in millets protect against oxidative stress, reducing inflammation and the risk of chronic diseases. These properties contribute to overall health and may prevent conditions like cancer and heart disease.

Weight Management: Dietary fiber promotes satiety, reducing hunger and overall calorie intake, which can aid in weight management and obesity prevention. Including millets in the diet can be an effective strategy for those seeking to maintain or lose weight.

Culinary Uses and Innovations

Traditional Dishes: Millets are integral to various cultures and cuisines:

- **Porridges:** Such as "ragi mudde" in India, made from finger millet.
- **Flatbreads:** Including "bajra roti" made from pearl millet flour.
- **Fermented Foods:** Like "idli" and "dosa" in South India, which can be made using millet batter.

Modern Food Products: The food industry is innovating millet-based products to cater to modern consumers:

- **Gluten-Free Products:** Millets are naturally gluten-free, making them ideal for individuals with celiac disease or gluten intolerance.
- **Snacks:** Millet flakes, puffs, and bars are gaining popularity as healthy snack options.
- **Bakery Items:** Incorporating millet flours in bread, cookies, and cakes enhances their nutritional value.
- **Beverages:** Millet-based beers and non-alcoholic drinks are being developed for niche markets.

Processing Techniques: Advancements are overcoming utilization challenges associated with millets:

- **Decortication:** Improved milling methods reduce antinutritional factors and enhance palatability.
- **Extrusion Cooking:** Produces ready-to-eat products with desirable textures and extended shelf life.
- **Fermentation:** Enhances the bioavailability of nutrients and improves flavour profiles.

Challenges in Millet Promotion

Consumer Acceptance: Millets are sometimes perceived as "poor man's food," leading to lower acceptance among urban consumers. Taste preferences and lack of awareness about their benefits contribute to limited consumption. Overcoming these perceptions requires education and marketing efforts.

Processing and Storage: Susceptible to spoilage due to high oil content leading to rancidity, millets require proper storage and processing methods to extend shelf life and maintain quality. Investment in storage infrastructure and processing technology is essential.

Policy and Research Gaps: Historically receiving less attention in agricultural policies and research funding compared to major cereals, millets suffer from limited access to improved seeds and agronomic practices. This hampers their potential yield and adoption rates among farmers.

Opportunities and Future Prospects

Government Initiatives: Recognizing their importance, governments are promoting millets:

- **Millet Missions:** Some countries have declared millets as "Nutri-Cereals" and are promoting them through national food security programs.
- **Public Distribution Systems:** Integrating millets into food assistance programs to improve nutritional outcomes among vulnerable populations.

International Recognition: The United Nations declared 2023 as the International Year of Millets, aiming to raise awareness and direct policy attention to their nutritional and economic benefits. This global recognition provides a platform to promote millet cultivation and consumption worldwide.

Research and Development: Advancements in genomics and breeding are developing high-yielding, disease-resistant millet varieties. Biofortification efforts aim to enhance micronutrient content, further improving their nutritional value and appeal.

Private Sector Engagement: Private sector involvement in developing millet-based products can drive innovation and expand market reach. Partnerships between farmers, processors, and retailers can strengthen the millet value chain, making it more profitable and sustainable.

Consumer Awareness Campaigns: Educational programs highlighting the health benefits and culinary versatility of millets can shift consumer perceptions. Cooking shows, social media campaigns, and community events can promote millet recipes and encourage adoption in daily diets.

Conclusion

Millets offer a multifaceted solution to some of the most pressing global challenges, including malnutrition, food insecurity, and environmental degradation. Their exceptional nutritional profile, climate resilience, and adaptability make them ideal candidates for sustainable agriculture and healthy diets. Addressing the challenges through concerted efforts in policy support, research, and consumer education can unlock the full potential of millets as future food. Embracing millets is not only a step towards better health but also a commitment to a sustainable and food-secure world.