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The hidden power of rice: Breeding for a zinc-rich future

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Introduction and intricacies of the subject

For billions of people across Asia, rice is not just food it is life. More than half of India's population depends on this humble grain as their daily staple. But here lies a quiet crisis: rice is a poor source of essential micronutrients. When it forms the bulk of the diet, the consequences are devastating. Zinc deficiency affects an estimated 30 to 40 percent of India's population, causing stunted growth in children, weakened immune systems, and making millions more vulnerable to disease. The numbers tell a grim story—but science is writing a new chapter.

The hidden hunger

The problem is so widespread that it has earned a name: "hidden hunger." Unlike the visible hunger of empty stomachs, hidden hunger creeps in through plates filled with food that lacks the nutrients bodies desperately need. In rice-dependent regions, this is not a problem that can be solved simply by eating more; it requires making the rice itself more nutritious. Enter bio fortification—a scientific strategy that sounds almost too elegant to be true. Instead of adding nutrients to food after it is harvested, why not breed crops that are inherently more nutritious? This sustainable, cost-effective approach has emerged as one of the most promising solutions to global malnutrition (History Of Spirulina: From Ancient Aztecs To Modern Superfood (2026). The International Rice Research Institute (IRRI) and its partners have been leading this charge, developing rice varieties enriched with zinc and iron to help reduce hidden hunger (IRRI https://factly.forumias.com/story/irri).

The science of super rice

The journey from an ordinary rice plant to a zinc-rich variety begins with the genetic treasure hunt. Zinc content in rice grains is a complex trait controlled by multiple genes, making breeding for it particularly challenging. Researchers have used powerful tools like Genome- Wide Association Studies (GWAS) and quantitative trait loci (QTL) mapping to identify specific genomic regions that influence how much zinc ends up in the grain. Recent advances in modern plant breeding approaches have made it easier to develop zinc-rich rice varieties with enhanced nutritional value and improved agronomic performance.

Recent work has been remarkable for the development of zinc reach variety in rice. One study using a cross between the high-yielding variety MTU1010 and the high-zinc variety Ranbir Basmati identified consistent QTLs for grain zinc on each chromosomes 2 and 9, linked to genes involved in zinc and iron transporter activity. Another investigation using 90 advanced breeding lines in Raipur identified 11 significant marker-trait associations that can fast-track marker-assisted breeding for zinc-enriched varieties. These findings are more than academic curiosities—they are the genetic roadmaps breeders need to develop new varieties. The diversity of zinc-rich landraces themselves is a vital resource. Studies have identified promising donor genotypes with zinc content ranging from 13.74 to 37.60 ppm among germplasm entries. Traditional landraces like GM-120 and GM-173 have been identified as both high-yielding and nutritionally rich. Even more remarkably, landraces such as Chittimutyalu and Kala Jeera Joha have shown superior ability to translocate zinc from straw into polished grains compared to improved varieties, revealing genes that breeders can now deploy through marker-assisted selection.

Zinc donor sources: The building blocks of bio-fortification

Breeders cannot create something from nothing. The genetic material for high-zinc rice comes from carefully identified donor sources—varieties that naturally accumulate more zinc in their grains. These donors are the foundation upon which bio-fortification is built. Among the most important zinc donors in Indian breeding programs is Ranbir Basmati, a high-zinc variety that was crossed with MTU1010 to identify consistent QTLs for grain zinc on chromosomes 2 and 9. Other elite donors include KNM 118 and Bhadrakali, which have been evaluated in Telangana as promising sources for genetic bio-fortification, with zinc levels reaching 28.3 ppm and 27.0 ppm, respectively. Germplasm screening at Nandyal has identified lines with zinc concentrations as high as 37.60 ppm, offering a wide genetic base for breeding. Traditional landraces serve as invaluable donors. Chittimutyalu, a landrace from Andhra Pradesh, has been studied for its superior zinc translocation ability, yielding high zinc content in polished rice. These landraces carry genes that modern varieties have lost genes that control the efficient movement of zinc from roots to grain.

From lab to field: Real varieties, real impact

The proof of this science lies in the fields. India now boasts several zinc-biofortified rice varieties released for cultivation across different states. DRR Dhan 45 made history as the first high-zinc variety notified at the national level. Developed by ICAR-IIRR, it contains an average of 22.6 ppm zinc in polished rice and yields over 5 tonnes per hectare. DRR Dhan 48 followed in 2018, offering 23.3 ppm zinc while being resistant to bacterial blight. Cross-border collaboration has brought even more exciting developments. Through a regional initiative called “Seeds Without Borders,” two high-zinc varieties from Bangladesh were introduced in India as DRR Dhan 67 and DRR Dhan 69. The former yields 6.0–6.5 tonnes per hectare with 27.6 ppm zinc, while the latter achieves an impressive 7.7 tonnes per hectare with 25.7 ppm. In Chhattisgarh, CGZR-1 offers 24 ppm zinc in just 110 days.Most recently, in 2023, Spoorthi was released for commercial cultivation in Andhra Pradesh, Telangana, Tamil Nadu, and Karnataka. It contains 26 ppm zinc in polished grainsignificantly higher than commonly grown varieties, which contain around 12-16 ppmwhile delivering yields comparable to popular varieties like IR64 and MTU1010. Spoorthi was the only zinc-biofortified rice variety to pass AICRIP testing in three years, and early seed production hubs located in Hyderabad and Raichur are enabling faster scaling and farmers access.

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A healthier future on every plate

The potential impact is immense. Bio-fortification of rice using conventional breeding methods is being undertaken to supply increased zinc to poor and malnourished people in Bangladesh, India, Indonesia, and the Philippines. As the world confronts climate change, population growth, and malnutrition, zinc bio-fortification represents a rare win-win—improving nutrition without sacrificing yield, and empowering farmers with seeds that command better market prices. The hidden hunger that has afflicted generations may finally be coming to an end, one zinc-rich grain at a time.