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Biofortified Grains, Healthy Nation: Wheat as a Game-Changer for Anaemia Control; Overview: Why Wheat is Important to the Story of Anaemia in India

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Wheat functions as the fundamental food source that supports India's battle against iron-deficiency anemia because it serves as a basic dietary component for people throughout the entire social spectrum. The high rates of anemia among women and children and adolescents require an immediate food-based solution which biofortified wheat varieties containing iron and zinc can provide through their natural integration into current eating habits. The nutrient-rich grains support blood haemoglobin concentration while delivering vital micronutrients which combat hidden hunger through their ability to maintain normal eating habits. The national nutrition programs POSHAN Abhiyaan and ICDS and Mid-Day Meal Scheme benefit from biofortified wheat which strengthens their ability to support vulnerable populations. The wide acceptance of wheat across different cultures together with its established nutritional value makes it an ideal sustainable solution for India's anaemia reduction strategy. Biofortified wheat emerges as a revolutionary national health solution because it merges agricultural innovation with public health objectives.

Keywords: Biofortified wheat, anaemia control, iron deficiency, nutrition security, hidden hunger, POSHAN Abhiyaan.

Introduction

Anaemia stands as a persistent public health problem in India because it affects a large number of women and children under five while showing no signs of improvement throughout multiple years. The data from national surveys and systematic reviews demonstrate that iron deficiency along with various forms of anaemia exist across all states and age groups (Jeevan, 2025; WHO, 2025) (Figure-1). The country must work towards reducing anaemia rates because this condition results in decreased work efficiency and causes developmental issues for children and increases health problems for mothers and their unborn babies (WHO, 2025). The story of anaemia in India revolves around wheat because it serves as the main food source for many people in the country. People in northern and central areas depend on wheat as their primary cereal-based food source which continues to provide their main source of nutrition (Mottaleb, 2023). Wheat functions as a vital food source which helps to enhance micronutrient consumption for various population groups including reproductive age women and school-aged children who experience the highest rates of anemia, as shown in Figure-2 (Mottaleb, 2023). Biofortification serves as a breeding process which enhances staple crops with increased micronutrient levels to create a sustainable method for boosting iron and zinc intake through food systems. The research on iron-biofortified pearl millet shows positive results for improving iron levels while Indian research and implementation

partners work to advance biofortified wheat through delivery systems and research programs (Finkelstein, 2015; HarvestPlus/partners, 2025). The research on fortification and supplementation programs shows that multiple obstacles exist during their execution which include both coverage and uptake and bioavailability issues that prevent achieving large-scale anemia reduction (Chakrabarti, 2018; Gupta, 2024).

Central Role of Wheat in India's Food System

Wheat functions as a vital agricultural resource which supports India's entire food system because it provides essential nutrition and helps maintain national food security. Wheat stands as the second most popular cereal after rice which supplies vital nutrition to numerous people who live in northern and western India according to Sharma and Kumar (2021). The Public Distribution System (PDS) depends on wheat to provide subsidized food access for low-income communities which helps fight hunger and malnutrition according to Singh et al. (2022). Wheat is central to the government's strategies for procurement and maintaining buffer stocks, which positions it as a key crop for maintaining economic equilibrium and managing price levels (Meena & Chauhan, 2023). Simultaneously, progress in biofortified wheat types, enhanced with iron and zinc, is proving to be an effective method for tackling micronutrient shortages, such as anaemia, in both rural and urban areas (Kaur et al., 2024). Furthermore, growing wheat supports a large number of farmers in the Indo-Gangetic Plains, significantly boosting rural incomes and the agricultural sector's contribution to the GDP (Pandey & Tripathi, 2023). Therefore, wheat goes beyond being just a crop; it is a vital element for nutrition, the economy, and food security, aiding India in its efforts to enhance public well-being and eradicate hunger.

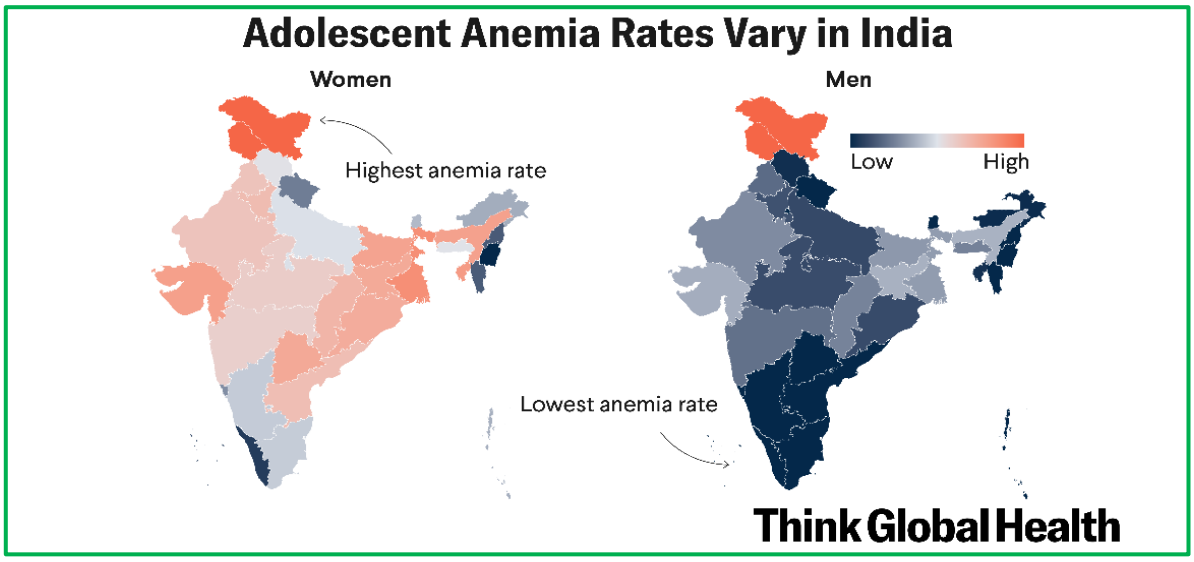

Figure-1 Adolescent Anaemia Rates (**Source: https://www.thinkglobalhealth.org/article/anemia-and-school-attendance-india)**

Biofortified Wheat Varieties: A Scientific Breakthrough

Biofortified wheat types are a notable scientific advancement in tackling micronutrient deficiency, specifically iron and zinc shortages that are common in India. Through traditional breeding, marker-assisted selection, and sophisticated genomic methods, scientists have effectively created wheat types enhanced with key micronutrients, without affecting output or grain quality (Velu et al., 2022). These enhanced cultivars, like zinc- and iron-dense lines distributed via national breeding schemes, have displayed considerable promise in fighting anaemia and hidden hunger in at-risk groups (Kaur et al., 2024). Biofortification is viewed as a lasting and economical strategy since the improved nutritional features are incorporated directly into the seed, allowing for a long-lasting effect that does not need regular external actions like supplements or fortification (Bouis & Saltzman, 2020). Research in the Indo-Gangetic Plains indicates that biofortified wheat produces yields that are similar to or greater than those of conventional types, which provides farmers with both nutritional and financial advantages (Singh et al., 2023) (Table-1). The creation of multiple biofortified wheat types

via ICAR, CGIAR, and HarvestPlus programs has led to innovative strategies for improving public health and addressing micronutrient deficits, as well as reinforcing food security in India (Tiwari & Kumar, 2023).

Table-1 Biofortified Wheat Types in India: Nutritional Properties, Adaptability, and Part in Decreasing Anemia

Variety	Released By / Year	Type of Biofortification	Key Features	Suitable Zone	Role in Anaemia Reduction
HD 3226	ICAR–IARI (2020)	Zinc-rich	High yielding, heat & drought tolerant, rust-resistant	NWPZ	Higher zinc improves immune function and supports iron absorption, indirectly reducing anaemia risk.
HD 3086	ICAR–IARI	Iron & zinc enriched	Good grain quality, stable yield, lodging resistant	NWPZ	Enriched Fe and Zn content helps improve haemoglobin levels and reduces hidden hunger.
HD 3293 (Pusa Tejas)	ICAR–IARI (2022)	High Zinc (≈ 45–50 ppm)	Early maturing, climate resilient, high protein	NWPZ	Increased zinc improves micronutrient status and supports better iron utilisation.
HI 8777 (Pusa Anmol)	ICAR–IARI (2022)	High Iron (≈ 40–45 ppm)	Drought tolerant, suited for rainfed systems	Central Zone	Higher iron intake helps directly combat iron-deficiency anaemia in women and children.
PBW Zn1	PAU, Ludhiana	Zinc enriched (≈ 45–47 ppm)	Good chapati quality, disease resistant	NWPZ	Zinc biofortification supports improved dietary diversity and reduces micronutrient malabsorption.
MACS 4028	AICRP on Wheat	High Iron (≈ 40 ppm)	Heat tolerant, suitable for drylands	Peninsular Zone	Iron-rich grains contribute to better haemoglobin formation in low-income rural populations.
WB 02	IIWBR	High protein, iron enriched	Suitable for low-input farming	Eastern Zone	Helps reduce dietary iron deficiency where wheat is a major staple.
HI 1633 (Pusa Ujala)	ICAR–IARI	Zinc fortified	Excellent chapati quality, drought hardy	Central Zone	Enhances zinc intake which aids iron metabolism and anaemia reduction.
HD 2733 (Pusa Bahar)	ICAR–IARI	Moderate Fe & Zn	Stable under stress, widely cultivated	NWPZ & NEPZ	Offers incremental micronutrient improvement across large populations consuming this staple.
Protein-Enriched Wheat Lines (QPM-type)	Multi-centre	Protein & micronutrient rich	Improved nutritional value	Multi-zone	Improves overall nutrient density, supports long-term reduction in malnutrition and anaemia.

Empowering Women and Children

Women and children should receive social status improvements because this action leads to complete societal development and better health outcomes and enduring economic growth. The process of empowering women through education and skills training and financial access and decision-making independence results in better nutrition and healthcare services which benefit both families and their surrounding communities (Gupta & Rani, 2022). Women who gain resource control and knowledge tend to invest in their children's healthy food and educational needs and preventive medical care which breaks the cycle of poverty and malnutrition that affects families across multiple generations (Sharma et al., 2023). Early learning combined with protection and proper nutrition for children leads to better brain

development and stronger abilities to learn and perform in the future (Kumar & Dutta, 2024). In impoverished rural regions, initiatives that integrate maternal learning with nutritional aid for children and communal support have proven effective in reducing anemia and stunted growth, as well as learning setbacks in children (Patel & Mehta, 2023). When gender-aware policies are put into practice alongside social safety nets, women and children are empowered to participate more fully in monetary, communal, and public endeavors, which safeguards their entitlements and fosters equitable advancement (Singh & Verma, 2024). The ethical imperative to aid women and children is just as important as the calculated advantage it offers in establishing a thriving and fruitful future.

Supporting National Nutrition Goals

Wheat is essential for India to meet its nutritional goals, which seek to decrease vitamin and mineral deficiencies and satisfy the needs of the National Nutrition Mission (POSHAN Abhiyaan). Products made from wheat are a staple food, allowing them to supply crucial daily energy and micronutrients to various groups, thereby promoting nutritional progress (Sharma & Verma, 2022). Biofortified wheat types, which have more iron, zinc, and protein, offer a clear answer to present public health concerns, as iron-deficiency anaemia is still common among Indian women and kids (Kaur et al., 2024). Studies show that biofortified wheat significantly increases haemoglobin levels and nutritional content while preserving regular eating habits, making it a culturally appropriate way to combat hidden hunger (Saini et al., 2023). Meena and Choudhary (2023) state that the government promotes children's nutrition via national programs by incorporating enriched wheat flour into the Integrated Child Development Services (ICDS) and Mid-Day Meal (MDM) schemes. Wheat is a vital food source for India as it is widely consumed, offers nutritional advantages, and facilitates food fortification for sustained nutrition and public health goals.

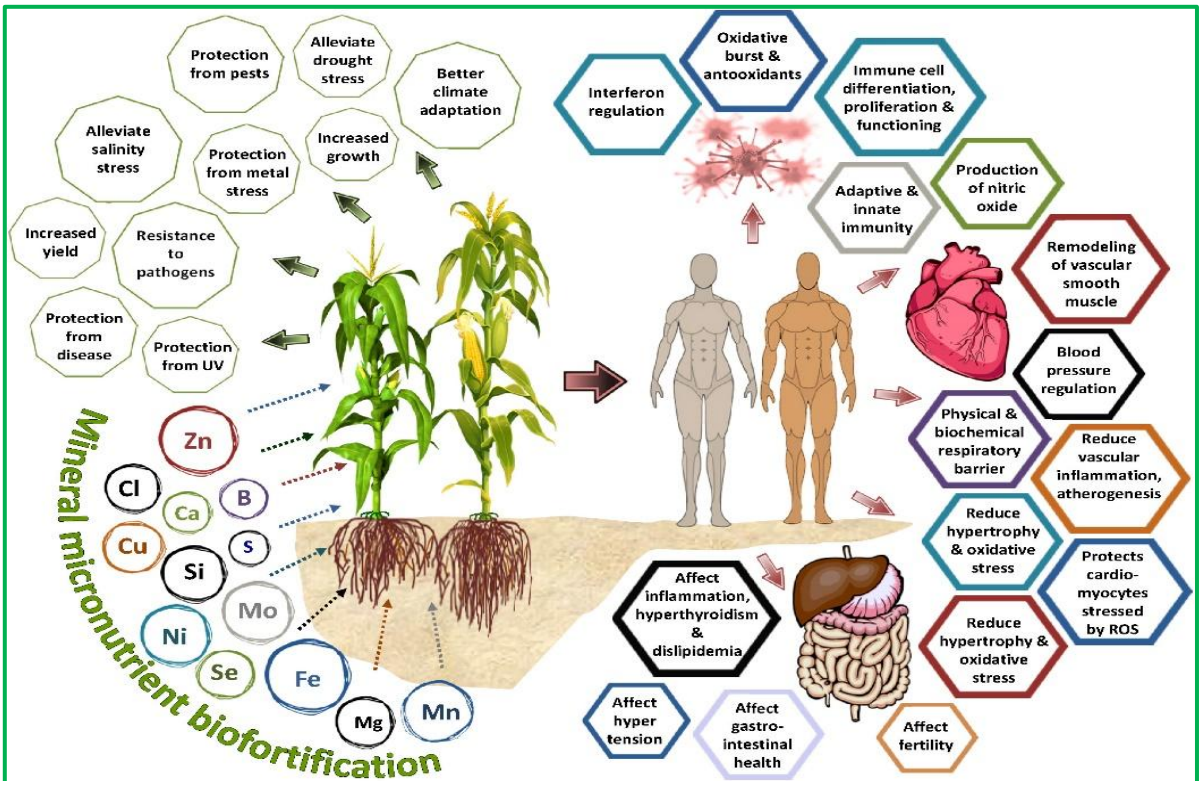

Figure-2 Influence of mineral micronutrient biofortification on the plant physiological processes and its relation to human health and immunity. (Source: Bhardwaj et al., 2022)

Farmer-Friendly and Climate Resilient

Enriched wheat acts as a resilient agricultural strategy that aids in resolving anemia issues and exhibits considerable environmental hardiness. These newly created wheat types, enhanced with iron and zinc, show resilience to heat, drought, and diseases. They also offer greater micronutrient concentrations, effectively addressing India's prevalent iron deficiency

anemia (Kaur et al., 2024). Farmers can easily incorporate these varieties without altering their farming methods, ensuring consistent harvests despite climate fluctuations (Singh et al., 2023). Given that countless people consume wheat as a dietary staple, biofortified grains can improve haemoglobin levels and overall nutrition while preserving existing eating patterns (Saini & Meena, 2023). Biofortified wheat serves as an innovative agricultural technique that offers dual benefits by reinforcing agricultural stability and backing national initiatives to lower anemia occurrences.

Conclusion

Biofortified wheat marks a significant step forward for India in its efforts to enhance public health, nutritional well-being, and farming that can withstand climate change. The development of wheat strains with elevated iron and zinc content provides an effective and socially accepted solution to combat iron deficiency which mainly affects women and children. These wheat varieties combine improved micronutrient content with heat tolerance and drought resistance and disease resistance to enhance both agricultural yield and combat hidden hunger. These systems operate with existing farming operations and public food distribution networks to extend their reach throughout the entire nation. Biofortified wheat presents a durable and user-friendly solution to help India achieve its long-term goals of reducing anemia rates and improving nutritional standards and public health.

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