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Biofortification Approaches to Boost the Nutritional Security in Cereals

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Biofortification is a probable and cost-effective means of providing micronutrients to populations with limited access to diverse diets and other micronutrient intercession. Micronutrient deficiency, also known as "hidden hunger" is one of humanity's most important provocations today. According to the World Health Organization (WHO) report about 3 billion people worldwide suffer from micronutrient deficiency. In India, malnutrition problems like anaemia, stunting, and underweight. Therefore, to overcome malnutrition in human beings, improvement of crop quality through the bio-fortification process for important crop plants through biotechnological applications is a sustainable solution. Target crops for increased micronutrient status include rice and maize for Fe, Zn, Pro-vitamin A and wheat, pearl millet, sorghum, and small millets for Zn and Fe. Two approaches for biofortification i.e., agronomic and genetic used to increase nutrient levels in stable food crops. Bio-fortified crop varieties are developed by plant breeding using selective breeding and genetic modification. In wheat-recreated synthetics, wild relatives and landraces are being used as progenitors for high Zn/Fe sources. Pearl millet, as a species, has higher levels of Fe and Zn densities than other major cereal crops many varieties developed in pearl millet. In maize, QPM is a product of conventional plant breeding it produces more lysine and tryptophan than the most modern varieties. Given the severity of mineral malnutrition in humans worldwide, the biofortification of micronutrients, especially Fe and Zn, in cereals must be encouraged.

Role of Biofortification in Agriculture

Biofortification is a strategy in agriculture that involves increasing the nutritional content of crops through various breeding and agronomic practices. The primary goal of biofortification is to improve the nutritional quality of staple foods, addressing specific nutrient deficiencies in populations, particularly in developing countries. Here are some key aspects of the role of biofortification in agriculture:

Nutrient Enrichment: Biofortification aims to enhance the levels of essential nutrients such as vitamins, minerals, and micronutrients in crops. This is particularly important for addressing widespread nutrient deficiencies, such as vitamin A, iron, zinc, and other essential micronutrients.

Crop Breeding: Traditional breeding methods, as well as modern biotechnological approaches, are employed to develop crop varieties with increased nutrient content. For example, biofortified crops may include varieties of rice, wheat, maize, and sweet potatoes with higher levels of key nutrients.

Improved Human Health: By increasing the nutritional content of staple foods, biofortification contributes to improving the health of populations, especially in areas where people rely heavily on a few staple crops. For instance, vitamin A-enriched crops can help combat vitamin A deficiency, which can lead to blindness and other health issues.

Addressing Hidden Hunger: Biofortification targets "hidden hunger," a condition where people may be consuming enough calories but lack essential micronutrients, leading to malnutrition. By fortifying staple crops with key nutrients, biofortification helps address this hidden hunger and promotes overall well-being.

Sustainable Solution: Biofortification is considered a sustainable solution as it builds on existing agricultural practices. By integrating nutrient-rich varieties into the farming systems, it becomes a long-term and cost-effective strategy to combat malnutrition.

Farmer Acceptance: Successful biofortification programs require the acceptance and adoption of new varieties by farmers. It is essential to involve farmers in the development process, ensuring that the biofortified crops meet their needs in terms of yield, resilience, and other agronomic traits.

Diversification of Diets: Biofortification encourages the consumption of a diverse range of nutrient-rich crops, promoting dietary diversity. This helps reduce dependence on a limited number of staple foods and enhances overall nutrition.

Approaches of Biofortification

✓ Agronomic approach

• Agronomic biofortification is the process of applying fertilizers with mineral elements that are deficient in the diet to increase the concentration of such elements in crops by foliar or soil application.

• The bioavailability of micronutrients along the entire soil-to-plant-to-food-to-human body pathway is essential for the efficiency of agronomic biofortification

✓ Conventional breeding

• Conventional breeding is a commonly recognized method of biofortification. It offers an economical and sustainable substitute for agronomic and transgenic methods.

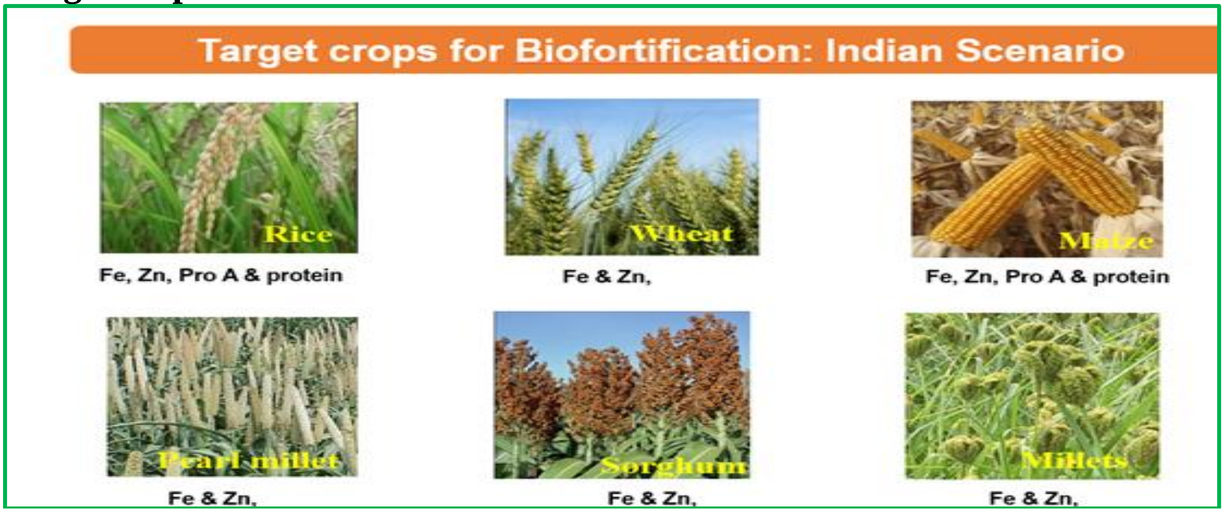
• To produce plants with the required nutrient and agronomic attributes, parent lines rich in nutrients are crossed with recipient lines that have the right agronomic qualities over a number of generations.

✓ Transgenic breeding

• For the purpose of biofortification, transgenic breeding is used when plant species exhibit little to no genetic diversity in their nutritional content.

• Irrespective of taxonomic or evolutionary position, it is the expression and transfer of desired genes from one species to another.

Target crops for Biofortification: Indian Scenario



Rice

- **CR Dhan 310**: It has been released in National level as first high protein rice variety for the states of Odisha, Uttar Pradesh and Madhya Pradesh. It has medium duration (120-125 days), semi-dwarf plant type (110 cm) with medium slender and good grain, quality.
- **CR Dhan 311**: It has been released by SVRC for Odisha as nutrient rich rice and notified by Govt. of India. It has high protein content (10.1%) and moderately high level of Zn content (20 ppm) in 10% polished rice.
- **DRR Dhan 45**: First high zinc variety notified in India. Semi-dwarf medium duration (125 days) for irrigated conditions.
- **Protezin**: It contains 9.02% protein + 20.9 ppm Zn with grain yield of 53.56 q/h. Promising in West Bengal, Odisha, Punjab, Telangana & Kerala.
- **IET24557**: It contains 26 ppm Zn, and medium slender grains and also with three BLB resistance genes.

Wheat

- **HPBW 01**: High Zn (40.6 ppm) and Fe content (40 ppm) variety with 12.3% protein. Average seed yield: 51.7 q/ha. Maturity in 141 days. It resistant to yellow and brown rusts.

WB2: High Zn (42 ppm) and Fe (40 ppm) with 12.4% protein. Average seed yield of 51.6 q/ha. Maturity at142 days and it resistant to yellow rust, brown rust and highly resistant to powdery mildew.

Maize

- **Pusa HM4 Improved**: It contains tryptophan 0.91% and lysine 3.62%. Recommended for North Western Plain Zone of Punjab, Haryana, Delhi, Uttarakhand (Plain), UP.
- **Pusa HM8 Improved**: It contains tryptophan 1.06% and Lysine 4.18%. Recommended for Peninsular Zone (PZ): Maharashtra, Karnataka, Andhra Pradesh and Tamil Nadu.
- **Pusa HM9 Improved**: Tryptophan 0.68% and Lysine 2.97%. Recommended for North Eastern Plain Zone (NEPZ): Bihar, Jharkhand, Odisha, Uttar Pradesh, West Bengal.