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Bio-fortification: The Way to Secure Nutritional Security through Crops

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Abstract
Micronutrient malnutrition, which affects more than 50% of the world's population, is regarded as one of the biggest global problems currently facing humanity. Micronutrient malnutrition, also referred to as hidden hunger, is primarily brought on by a deficiency in micronutrients, especially Zn and Fe, and appears to be quite common among mothers and preschoolers. The practise of "biofortification," which increases the bioavailable amounts of essential nutrients in crops' edible parts through agronomic intervention or genetic selection, has the potential to reduce undernutrition and secret hunger. The Consultative Group on International Agricultural Research has looked into genetic options to increase the bioavailability of Fe and Zn in staple crops like rice, wheat, maize, kidney beans and cassava.

Introduction
It is made up of biological functions. It refers to food crops that are nutrient-improved and have a higher bioavailability to the human population because they were developed and grown using modern biotechnology techniques, conventional plant breeding, and agronomic methods. It also provides a long-term, viable, and reasonably priced method of providing more micronutrients. It is done for some specific crops, including rice, wheat, beans, and other grains and legumes. The micronutrient deficiencies of iron, zinc, and vitamin A are those that have the greatest global health consequences and are the main subject of biofortification research. In response to the urgent need for the nutritional biofortification of the staples (Iron and Zinc), the Indian Council of Agricultural Research (ICAR) has launched numerous programmes in a variety of crops, including pearl millet, wheat, sorghum, rice, and lentils. A new crop cultivar called "Dhanshakti" with added iron will formally make its debut in India. It is a part of the government of India's Nutri-Farm Pilot Programme.

Why do we require bio fortification?
1. Because the world's population is constantly growing, biofortification is a crucial technique to meet people's desire for nutritious food.
2. There are 1.5 billion overweight persons worldwide.
3. An increase in malnutrition, underweight, and obesity.

The objectives of biofortification
Biofortification works with higher concentrations of vitamins and minerals or higher amounts of protein and better fats and focuses on practical solutions to promote public health. The objectives of biofortification in order to improve nutritional quality the followings:
1. Quantity and quality of protein
2. Quantity and quality of oil

3. The content of vitamins
4. Micronutrients and minerals content
5. Other trace elements

Biofortification techniques/methods

Three fundamental approaches transgenic, conventional and agronomic incorporate, respectively the use of crop breeding, fertilization techniques, and biotechnology to biofortify critical micronutrients into crop plants. The three biofortification techniques are listed below.

1. Agronomic practices: To temporarily improve crops' nutritional and physical health; agronomic biofortification entails physically applying nutrients to the plants. The nutritional status of people is also improved by consuming these meals. Agronomic biofortification is simple and inexpensive, but it needs to take the environmental impact, application method and nutrient source into particular account. These have to be used repeatedly throughout each crop season, which makes them occasionally less cost effective. The quality of wheat, rice, and maize has been improved via agronomic biofortification rather successfully. These are methods farmers employ to manage crops, enhance water use, and improve the environment. They also involve applying organic fertilizers to raise the number of micronutrients in the soil.

2. Conventional plant breeding: Conventional breeding is the biofortification technique that is most well-known. It offers an effective, inexpensive alternative to agronomic and transgenic based methods. The trait of interest must possess sufficient genotypic variation in order for conventional breeding to be effective. To improve the number of vitamins and minerals in crops, this variation can be employed in breeding plans. In traditional plant breeding, parent lines with high nutrient levels are crossed with recipient lines that have desirable agronomic features over several generations to produce plants that have the desired agronomic and nutrient traits.

3. Genetic engineering modification/transgenetic method: The transgenic approach can be a viable option when there is little or no genetic diversity for the creation of biofortified crops diversity in the amount of nutrients available in different plant types. Incorporating genes that raise the bioavailability and concentration of micronutrients, as well as the presence of anti-nutrients that limit the bioavailability of nutrients in plants can all be done using transgenic methods. Successful transgenic techniques may be shown in the production of high provitamin lysine-rich maize, high unsaturated fatty acid soybeans, high provitamin A Golden rice, high provitamin A, and iron-rich cassava. In this method DNA is injected into an organism's genome through genetic engineering to modify it, introducing new or different traits like disease resistance. Illustrations of biofortification a few instances of food crops that have been bio-fortified.

Benefits of biofortification

Biofortification main goal is to benefit society in a significant way. The benefits of biofortification are listed below;

- Enhancing the bioavailability and concentration of nutrients in crops.
- Improvement in peoples' general health.
- It is a sustainable agriculture practice that doesn't cost extra for consumers.
- Crops that have been bio-fortified have a better possibility of eradicating the malnutrition issue in the future.

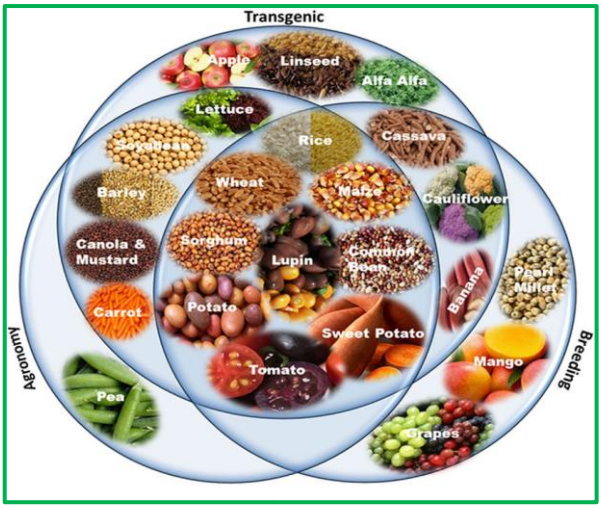

Figure 1: - Biofortification of different cereals

- Biofortification is a practical and cost-effective way to deliver micronutrients to persons who have limited access to different diets and other micronutrients.
- Biofortification uses non-genetically modified techniques like conventional breeding and transgenic procedures, it is superior to genetically modified (GM) crops.
- It boosts crop production and makes plants more resistant to pests, diseases, and droughts.
- It aids in the well-being of farmers and also has the potential to assist the underprivileged.
- It is quite affordable once the preliminary study is completed. The procedure is simple to scale up and duplicate.
- Biofortification is a sustainable, economical solution that can assist in resolving this dilemma in a nation like India, which has significant nutritional challenges.
- Numerous research and publications indicate that India faces a significant problem with under nutrition.
- Anemia and iron deficiency are widespread issues, especially in economically disadvantaged areas.
- In homes that frequently consume foods that are deficient in micronutrients and are more prone to concealed hunger, biofortification is especially beneficial.

Examples of bio-fortification

Crops / verities	Fortified Nutrients
Wheat - HI 1633 HD 3298 DBW 303 & DDW 48	Protein, Iron and Zinc Protein and Iron Protein
Little millet - CLMV 1	Iron and Zinc
Groundnut - Girnar 4 & 5	Oleic acid
Yam - Sri Neelima and DA 340	Iron, Zinc and Anthocyanin
Rice - CR Dhan 315	Zinc
Maize - Hybrid 1,2 &3	Lysine and Tryptophan
Mustard - Pusa mustard 32	Low erucic acid
Sweet potato, Legumes, Rice, Cassana, beans	Iron
Wheat, Sweet potato, Rice, Maize, beans	Zinc
Cassana, maize, sweet potato	Pro vitamin-A carotenoid
Cassana, sorghum	Amino acid and protein

Biofortification challenges

Some of challenges faced in biofortification are as following: -

Biofortification could be difficult if rural impoverished people receive the right education. However, the biofortification method should not change the food's flavour or colour. Some grains changes colour during biofortification and due to this people hesitate to accept biofertified food. i.e., Golden rice.

Way forward

Having a lot of variations in the dietary (food) habits of across the country with variation in geographical regions mean that biofortification should be catered to the local needs of the population.

Summary

One of the most concerning issues today is malnutrition, particularly in developing and underdeveloped nations. In India, more than 5% of the population, primarily farmers, lived in poverty. As a practical solution, biofortification holds the potential to lower malnutrition on a global scale. The prevention and treatment of micronutrient deficiencies in vulnerable populations, particularly women and children, as well as social, economic, and environmental issues have all benefited from studies on biofortification.