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Biofortification in India: Promoting Nutritional Security for a Healthy Nation

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Abstract
Biofortification is emerging as a promising solution to combat malnutrition and improve food security in India. This review explores the significance of biofortification, which aims to enhance the nutritional quality of staple food crops through conventional breeding, agronomic practices, and genetic engineering. India has made considerable progress in developing biofortified crop varieties with increased levels of essential nutrients such as provitamin-A, iron, zinc, and protein. These biofortified crops hold the potential to address nutritional deficiencies and promote a healthier nation, but overcoming challenges related to awareness and adoption is crucial for ensuring long-term sustainability and impact.

Keywords: biofortification, nutritional security, malnutrition, crop varieties, food security

Introduction
In a world where malnutrition continues to be a pressing issue, biofortification has emerged as a promising solution to improve the nutritional quality of food crops. Through conventional plant breeding, agronomic practices, and modern biotechnology, biofortification aims to enhance the levels of essential nutrients in staple food crops, thus promoting both nutritional security and food security. India, with its vast agricultural resources, has made significant progress in the field of biofortification, developing and releasing numerous nutrition-rich crop varieties across different regions of the country.

The Significance of Biofortification
Biofortification offers several advantages over other approaches to combat malnutrition. Firstly, it effectively reaches the malnourished in rural areas, making it an ideal strategy for improving the nutritional status of vulnerable populations. Unlike artificially fortified and processed foods, biofortified crops are accessible and affordable for poor communities. Additionally, biofortification is a cost-effective approach, as it involves introducing nutritionally superior traits into existing crop varieties without incurring significant additional expenses. Moreover, biofortification is a sustainable solution, as once the nutritionally superior crop varieties are developed, their seeds and products continue to contain the same beneficial traits without further investment or processing.

Biofortification Approaches
Biofortification can be achieved through three main approaches: agronomic, conventional breeding, and genetic engineering. The agronomic approach involves adding appropriate nutrients as inorganic compounds during crop cultivation, while conventional breeding focuses on breeding crop varieties with enhanced nutrient levels. Genetic engineering, on the

other hand, involves introducing genes from novel sources to confer desirable traits in crops. Each approach has its advantages and applicability depending on the specific crop and nutrient being targeted.

Present Status of Biofortification in India

Indian agricultural institutes, including the Indian Council of Agricultural Research (ICAR) and state agricultural universities, have played a pivotal role in developing and releasing biofortified crop varieties. So far, a total of 71 nutrition-rich crop cultivars have been developed and released in important crops like wheat, rice, maize, pearl millet, finger millet, groundnut, mustard, lentil, and many more. These biofortified varieties have significantly contributed to the nutritional security of the country, serving as an important source of livelihood for the poor.

Biofortified Crop Varieties in India

The development of biofortified crop varieties in India has focused on improving the levels of essential nutrients such as provitamin-A, vitamin-C, protein, iron, zinc, calcium, lysine, tryptophan, anthocyanin, oleic acid, and linoleic acid. Wheat, maize, pearl millet, and rice have received the most attention, with a wide range of biofortified varieties available. For instance, biofortified rice varieties like DRR Dhan-45, DRR Dhan-48, and Zinco Rice MS have higher levels of zinc content, addressing the deficiency prevalent among the population.

Biofortified Varieties

1. Rice: CR Dhan-310 has high protein content (10.3%) and DRR Dhan-45, DRR Dhan-48, DRR Dhan-49, Zinco Rice MS, and CR Dhan-315 have increased zinc content (~24 PPM).
2. Wheat: HD-3249, DBW-187, PBW-771, PBW-757, HD-3171, and other varieties have increased iron and zinc content (42 PPM). Some varieties also have higher protein content (12.5%).
3. Maize: Vivek QPM-9, Pusa HM-4 Improved, and other varieties have improved lysine and tryptophan content (4.19%). Pusa VH-27 improved has increased provitamin-A content (5.49 PPM).
4. Pearlmillet: HHB-311, AHB-1200Fe, HHB-299, RHB-234, and other varieties have increased iron and zinc content (83 PPM).
5. Finger Millet: VR 929 (Vegavathi) has significantly higher iron content (131.8 PPM) and CFMV-1 and CFMV-2 are rich in calcium, iron, and zinc.
6. Lentil: Pusa Ageti Masoor and IPL-220 have increased iron content (65 PPM) and IPL-220 also has increased zinc content (51 PPM).
7. Groundnut: Girnar-4 and Girnar-5 varieties have higher oleic acid content (78.5%).
8. Little Millet: CLMV-1 has increased iron and zinc content (59 PPM and 35 PPM).
9. Linseed: TL 99 has higher linoleic acid content (58.9%).
10. Mustard: Pusa Mustard-30, Pusa Mustard-32, and Pusa Double Zero Mustard-31 have reduced erucic acid content (1.20%).
11. Soybean: NRC-127, NRC-132, and NRC-147 have specific traits, such as being kuntiz trypsin inhibitor-free, lipooxygenase-2 free, and high oleic acid content.
12. Cauliflower: Pusa Beta Kesari 1 has higher provitamin-A content (10 PPM).
13. Pomegranate: Solapur Lal is rich in iron, zinc, and vitamin-C.
14. Potato: Kufri Manik and Kufri Neelkanth have anthocyanin content (0.88 PPM).
15. Sweet Potato: Bhu Sona has high provitamin-A content (14.0 mg/100g) and Bhu Krishna has significant anthocyanin content (90.0 mg/100g).
16. Greater Yam: Sree Neelima and Da 340 have anthocyanin content, protein, zinc, and iron, as well as iron and calcium content respectively.

Impact and Future Prospects

The impact of biofortification in India has been significant in addressing malnutrition and promoting nutritional security. However, there is still a long way to go in terms of widespread adoption and awareness among farmers and consumers. Efforts are being made to popularize and promote the cultivation of biofortified crop varieties through programs like Nutri-sensitive Agricultural Resources and Innovations (NARI) and Value Addition and Technology Incubation Centres in Agriculture (VATICA). These initiatives aim to upscale the production and distribution of biofortified seeds and products through Krishi Vigyan Kendras (KVKs).

Role of Government and Organizations

The Indian government, along with national and international organizations, has been actively involved in promoting and supporting biofortification projects. Organizations like HarvestPlus, IRRI, and the Indian Council of Agricultural Research (ICAR) have collaborated on various research and development initiatives. The Food and Agriculture Organization (FAO) has also outlined future biofortification projects in India, focusing on zinc and iron biofortification in staple crops like rice, wheat, and maize, as well as amino acid and protein biofortification in crops like sorghum and cassava.

Overcoming Challenges and Ensuring Sustainability

While biofortification shows great promise, there are challenges that need to be addressed to ensure its long-term sustainability. These challenges include intellectual property rights, regulatory constraints, and awareness among farmers and consumers. Efforts should be made to streamline the release and adoption of biofortified crop varieties, ensuring that they reach the intended beneficiaries effectively.

Conclusion

Biofortification is a powerful tool in the fight against malnutrition, and India has made significant progress in developing and releasing biofortified crop varieties. By improving the nutritional quality of staple food crops, biofortification contributes to both nutritional security and food security. With continued efforts in research, development, and awareness, biofortification has the potential to transform the health and well-being of millions of people in India, paving the way for a healthier and more prosperous nation.

References

1. Allen L, de Benoist B, Dary O, Hurrell R. Guidelines on Food Fortification with Micronutrients. World Health Organization and Food and Agricultural Organization of the United Nations, Geneva. 2006.
2. Bouis HE, Welch RM. Biofortification-A sustainable agricultural strategy for reducing micronutrient malnutrition in the Global South. Crop Sci. 2010;50:S20-32.
3. Devendra Kumar Yadava, Partha Ray Choudhury, Firoz Hossain, Dinesh Kumar, Trilochan Mohapatra. Biofortified Varieties: Sustainable Way to Alleviate Malnutrition (Third Edition). Indian Council of Agricultural Research, New Delhi. 2020.
4. Global Food Policy Report, 2016. Washington, DC: International Food Policy Research Institute (http://ebrary.ifpri.org/utils/getfile/collection/p15738coll2/id/130207/filename/130418.pdf).
5. Link to HarvestPlus India https://www.harvestplus.org/where-we-work/india
6. National Family Health Survey-4. 2015-16. Ministry of Health and Family Welfare, Govt. of India.
7. Neeraja CN, Babu V, Ram Sewa, Hossain Firoz, Hariprasanna K, Rajpurohit BS et al. Biofortification in Cereals: Progress and Prospects. Current Science 2017;113:1050-1057.

8. Pandey N, Hossain F, Kumar K, Vishwakarma AK, Muthusamy V, Manjaiah KM, Gupta HS. Microsatellite marker-based genetic diversity among quality protein maize (QPM) inbreds differing for kernel iron and zinc. Molecular Plant Breeding 2015, 6.
9. Sustainable Development Goals United Nations. Department of Economic and Social Affairs Sustainable Development (https://sdgs.un.org/goals). 2015.
10. Swamy BPM, Rahman MA, Inabangan-Asilo MA, Amparado A, Manito C, Chadha-Mohanty P et al. Advances in breeding for high grain zinc in rice. Rice, 2016;9:49.
11. Tang G, Qin J, Dolnikowski GG, Russell RM, Grusak MA. Golden Rice is an effective source of vitamin A. The American journal of clinical nutrition. 2009;89(6):1776-1783.
12. Yadav DN, Bansal S, Tushir S, Kaur J, Sharma K. Advantage of biofortification over other technologies. In Wheat and Barley Grain Biofortification. Woodhead Publishing. 2020, 257-273.
13. Yadava DK, Choudhury PR, Hossain F, Kumar D, Mohapatra T. Biofortified Varieties: Sustainable Way to Alleviate Malnutrition (Second Edition). Indian Council of Agricultural Research, New Delhi. 2019, 44.