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Biofortification and Its Role in Achieving Nutritional Security in India

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Malnutrition has emerged as one of the most serious health issues worldwide. The consumption of unbalanced diet causes malnutrition which is more prevalent in the underdeveloped and developing countries. Deficiency of proteins, essential amino acids, vitamins and minerals leads to poor health and increased susceptibility to various diseases, which in turn leads to significant loss in Gross Domestic Product and affect the socio-economic structure of the country. Although various avenues such as dietary-diversification, food-fortification and medical-supplementation are available, biofortification of crop varieties is considered as the most sustainable and cost-effective approach. The newly developed biofortified crop varieties besides serving as an important source for livelihood to poor people assume great significance in nutritional security.

Biofortification is a feasible and cost-effective means of delivering micronutrients to populations that may have limited access to diverse diets and other micronutrient interventions. Since 2003, Harvest Plus and its partners have demonstrated that this agriculture-based method of addressing micronutrient deficiency through plant breeding works. More than 20 million people in farm households in developing countries are now growing and consuming biofortified crops. To reach one billion people by 2030, there are three key challenges: 1) mainstreaming biofortified traits into public plant breeding programs; 2) building consumer demand; and 3) integrating biofortification into public and private policies, programs, and investments. While many building blocks are in place, institutional leadership is needed to continue to drive towards this ambitious goal.

Biofortification is a process of increasing the concentration of vitamins and minerals in a crop through plant breeding, transgenic techniques or agronomic practices. Biofortified staple crops, when consumed regularly, will generate measureable improvements in human health and nutrition. Biofortification provides a comparatively cost-effective, sustainable, and long-term means of delivering more micronutrients. The biofortification strategy seeks to put the micronutrient-dense trait in those varieties that already have preferred agronomic and consumption traits, such as high yield and disease resistance. The nutrition evidence on bioavailability and efficacy is growing. Completed nutrition studies for each crop are briefly discussed. Biofortification is yet to be fully scaled-up in a single country, but much evidence and experience has been assembled to support its eventual effectiveness. Policies to support crosssectoral implementation at all levels, as well as increasing the evidence base, will contribute to making biofortification a cost-effective investment in a more nourishing future.

Biofortification through plant breeding is a sustainable approach to improve the nutritional profile of food crops. The majority of the world's population depends on staple food crops; however, most are low in key micronutrients. Biofortification to improve the nutritional profile of pulse crops has increased importance in many breeding programs in the past decade. The key micronutrients targeted have been iron, zinc, selenium, iodine, carotenoids, and folates. In recent years, several biofortified pulse crops including common beans and lentils have been released by Harvest Plus with global partners in developing countries, which have helped in overcoming micronutrient deficiency in the target population. This review will focus on recent research advances and future strategies for the biofortification of pulse crops.

Micronutrients, iron (Fe), zinc (Zn), selenium (Se), iodine (I), carotenoids, and folates are essential nutrients required for human growth and development, as these contribute to various metabolic functions in human. The majority of the world's population depends on plant-based foods which are often low in key micronutrients and do not meet the recommended daily allowances (RDA). Micronutrient malnutrition is commonly known as "hidden hunger" and affects one in three people worldwide. Micronutrient deficiencies may lead to serious illnesses such as poor growth, intellectual impairments, perinatal complications, and increased risk of morbidity and mortality. Further, they aggravate infectious and chronic diseases including osteoporosis osteomalacia, thyroid deficiency, colorectal cancer, and cardiovascular diseases and thus greatly impact quality of life. Deficiencies of Fe, Zn, folic acid, and β-carotene are global issues, but they are more predominant in Asian, African, and Latin American countries and affect more than two billion people. Micronutrient deficiency and undernourishment of pregnant mothers affects nearly 50% of the world's population. Food crops rich in nutrients could address deficiencies of micronutrients and thus provide a sustainable solution to global health issues.

There are two main behavioural issues related to biofortification: one for the farmer and one for the consumer. Farmers are interested in planting new varieties that are agronomically superior to the current varieties they plant, for example cultivars that are more drought resistant, have more yield or less susceptibility to diseases. Crops with improved micronutrient concentration with the same or poorer agronomic performance will not be accepted and adopted by farmers. Therefore, biofortified varieties must be agronomically equivalent or preferably superior to the less nutrient dense market and traditional varieties with which they will compete. Provitamin A carotenoids impart colour to foods; therefore, biofortification with these carotenoids will change the colour of crops. Thus, motivating consumers to change their buying and eating habits from white- to orange-fleshed maize, sweet potato can be a challenge. Furthermore, acceptability has been shown to be improved by providing information about the health benefits of the biofortified crop to the consumer.

Biofortified crops are often assumed to be transgenic or genetically modified crops. While the thrust of biofortification activities through international projects focused on the production of nutritionally enhanced crops through conventional breeding, increasingly, more efforts are using genetic modification to add value to staple and non-staple crops. However, this is changing with the use of cheaper and more efficient laboratory tests to identify the promising varieties and because biofortification is being recognized as a sustainable strategy to be included in various country programmes on food and nutrition security. Efforts are underway around the world to create demand for high yielding biofortified crops and to develop healthy food products from biofortified crops so that non-farmers and urban consumers can also benefit.