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Biofortification in Horticultural Crops

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In recent decades, micronutrient malnutrition or "hidden hunger" has become a major problem. The reason for this "hidden hunger" lies in the quality, rather than quantity, of the food available, as well as the fact that in many poor developing countries people eat mostly low-protein staple crops. Because foods that are high in micronutrients, such as vegetables, fruits, dairy and meats are expensive, resource-poor people rely primarily on a few starchy staples that are rich in energy, but not in micronutrients. As a consequence, dietary diversity to achieve micronutrient intake adequacy becomes a luxury that the poor can often not afford. The world has made great progress in alleviating poverty and ensuring food and nutritional security, however many countries are still far from reducing hunger, malnutrition, and poverty. Modern agriculture has been able to meet the nutritional needs of poor populations in developing countries for most of the past century. Agricultural research in developing countries has traditionally focused primarily on production rather than nullifying nutritional concerns. However, agriculture needs to adopt a new paradigm that will not only ensure better food production, but also deliver better food quality. In traditional agriculture, nutritional content of plant foods can be partially enhanced, however biofortification is a practice in which nutrients are fortified into food crops using agronomic, conventional and transgenic breeding methods in order to address the negative impacts of vitamin and nutrient deficiencies in the long run.

Bio-fortification refers to increasing genetically the bioavailable mineral content of food crops. Developing biofortified crops also improves their efficiency of growth in soils with depleted or unavailable mineral composition. Producing nutritious and safe foods, sufficiently and sustainably, is the ultimate goal of biofortification.

As a cost-effective, sustainable, and long-term method of delivering more micronutrients in rural areas, biofortification is also capable of supplying natural-fortified foods to populations that lack access to commercially-marketed fortified foods. The consumption of biofortified staple foods will not provide as high levels of minerals and

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vitamins as supplements or industrially fortified foods, but they will help to increase the daily adequacy of micronutrient intakes of individuals over their lifetime.

In general, biofortification prioritizes staple foods in developing countries. CGIAR (Consultative Group on International Agricultural Research) Micronutrients Project aims to build a package of tools for plant breeders to produce mineral- and vitamin-dense cultivars for Fe, Zn, and vitamin A in wheat, rice, maize, beans, and cassava. Among the horticultural crops, the following are especially emphasized: cassava, sweet potato, and banana, which contain high levels of provitamin A carotenoid, potato, and common bean, which contain high levels of iron and zinc, cowpeas, which contain high levels of iron, spinach, onion, broccoli, cabbage, lettuce, and tomato, which contain high levels of iron. In addition, the Indian Agricultural Research Institute has developed several vegetable crops rich in vitamins and minerals, including carrots, spinach, and pumpkin enriched with vitamin A, bitter gourd, bathua, mustard, tomato, Fe, and Ca-enriched spinach and bathua, and beans, lablab, French, and garden peas enriched with protein. One of the major challenges in biofortifying vegetable and fruit crops is setting appropriate target levels for the micronutrient content in edible tissue to achieve adequate intakes. As a food-based strategy, the additional micronutrient intake resulting from biofortification would ideally be enough to fill the gap between current intakes and the amount that would result in the majority of the population having intakes above the theoretical mean dietary requirement level (the estimated average requirement, or EAR). In order to reach one billion people by 2030 with biofortified crops, policymakers must prioritize agriculture's role in improving health. The national governments and multilateral institutions should ensure that biofortification is included in the nutrition agenda. Biofortified traits must be mainstreamed across the product lines of public and private breeding partners. The food processing industry and other actors along the value chain must incorporate biofortified crops into their products. Only through a collaborative effort that reaches across the value chain will biofortification become business as usual.