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Role of Biofortification in Agriculture

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Biofortification was principally developed as a food-based strategy to address widespread deficiencies of vitamin A, iron, and zinc that remain prevalent to the greatest extent in low-income countries. Biofortification is the process by which the nutrient density of food crops is increased through conventional plant breeding, and/or improved agronomic practices and/or modern biotechnology without sacrificing any characteristic that is preferred by consumers or most importantly to farmers.

The biological mechanism for biofortified crops improving nutritional status is simple: Biofortified crops are more nutrient-dense than non-biofortified varieties. Therefore, assuming similar micronutrient bioavailability and retention after cooking or processing and storage, persons will consume and absorb more micronutrients from eating biofortified crops than from the same amount of non-biofortified crops. In populations with a diet limited in these micronutrients, the consumption of biofortified staple crops can improve micronutrient intake.

The impact, scalability and sustainability of biofortification depends on whether or not

(i) Conventional crop breeding can increase nutrient levels without compromising yield;
(ii) Extra nutrients in crops can measurably improve micronutrient status;
(iii) Farmers are willing to grow biofortified crops and consumers are willing to eat them, and also on its
(iv) Cost-effectiveness.

How are Crops Biofortified?

There is substantial natural variation of micronutrient content (e.g. iron) in many staple crops, including maize, beans, cassava, rice and millet. In biofortification, conventional crop breeding techniques are used to identify varieties with particularly high concentration of desired nutrients. These are cross-bred with highyielding varieties to develop biofortified varieties that have high levels of, for instance, zinc or betacarotene, in addition to other productivity traits desired by farmers. The biofortified seeds or cuttings are made available through extension programmes, market mechanisms or by programmes targeting nutritionally vulnerable smallholders. Some research has also been focused on improving micronutrient levels in crops through using transgenic methods when, for instance, natural variation in micronutrient content does not exist across varieties of a particular staple crop. In such cases, genes can be transplanted across species. This approach can involve considerable time and cost to ensure efficacy and food and environmental safety, and political debates about the use of transgenic crops for human consumption have slowed acceptance of transgenic varieties.

Deficiencies in lesser-known but equally important nutrients like selenium, copper, or vitamins E and K, also carry serious health threats. Such needs often go unidentified and unaddressed until a medical condition associated with the deficiency manifests itself. Because of this invisibility, such deficiencies are widely referred to as 'hidden hunger'. Micronutrient deficiencies particularly affect poor rural populations in low and middle income countries. But, perhaps surprisingly, micronutrient deficiencies are also associated with the growing problems of overweight and obesity, and with noncommunicable diseases. This is because a low quality diet tends to be nutrient-poor whether based on highly processed foods from which nutrients have been removed during processing, or on nutrient-poor foods in food insecure face these political and regulatory hurdles associated with transgenic varieties. So conventional breeding ensures a faster route to getting biofortified crops into the hands of farmers. All biofortified crops released till date are conventionally bred.

An important principle applied in the breeding process is to avoid compromising yield potential of biofortified varieties since this could make them less desirable to producers. Since biofortification is aimed at the rural poor, who often live in remote marginal environments and consume most of the staple foods they produce, adoption of biofortified varieties increases the chance that their micronutrient needs can be met, even if other interventions are not reaching them. As a result, the potential for nutritional impact on a very large scales at relatively low cost has been cogently argued and many developing country governments have since invested in promoting biofortified seeds.

Three primary issues have been identified that are required to make biofortification successful:

i. A biofortified crop must be high yielding and profitable to the farmer
ii. The biofortified crop must be shown to be efficacious and effective at reducing micronutrient malnutrition in humans
iii. The biofortified crop must be acceptable to both farmers and consumers in target regions where people are afflicted with micronutrient malnutrition.

Conclusion

Biofortification is evidence-based sustainable and cost-effective approach to address malnutrition through the development, release, and adoption of yield-competitive varieties possessing additional micronutrient content. Biofortification allows reaching relatively remote rural populations who have limited access or not a particular liking to commercially fortified foods and dietary diversification is not a valid option. We recognize that biofortification and other interventions are complementary strategies.

However, biofortification is particularly advantageous where households consume large amounts of food staples often poor in micronutrients and are most vulnerable to hidden hunger. It has been shown that farmers have adopted varieties of wheat with higher zinc content. However, we need to work with all stakeholders in the value chain to maximize impact of biofortified varieties/food. Hence, to scale out and strengthen the breeding pipeline and uptake of these varieties, all stakeholders including public, NGOs, and private seed and food companies need to work together. Agriculture investments and favorable policies to promote biofortification will enhance the availability of nutritious food to farming and non farming communities. Linking biofortification to the ongoing government initiatives such as inclusion of biofortified pearl millet in the PDS and MDMS to address malnutrition would trigger demand. Increased demand of biofortified food would create market opportunities for various players in the value chain. Wheat has the potential to make significant contributions to food and nutritional security in India.

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