

# Breeding Crops *for* Better Nutrition

“*Imagine a new breed of nourishing crops with essential micronutrients that can improve nutrition in malnourished populations, in even the most remote regions—crops such as iron rice, wheat packed with zinc and maize strengthened with vitamin A. These staples could be grown, and eaten, by farming communities throughout the developing world.*”

Photo: D. Marchand, IDRC

# Agriculture, a Tool to Im



Photo: IRRI

## A Hidden Hunger

More than 840 million people do not get enough food to meet their daily energy needs. However, far more—an estimated 3 billion people—suffer the insidious effects of micronutrient deficiencies because they lack access to more nutritious foods such as fruits, vegetables, and animal products. The

consequences of micronutrient malnutrition, also known as ‘hidden hunger,’ can be devastating; they include stunting, impaired cognitive ability, blindness, increased risk of disease, and premature death. Women and young children in developing countries are especially vulnerable.

Vitamin A, zinc, and iron are among the micronutrients most lacking in the diets of the poor in the developing world. Providing such nutrients through supplements and food fortificants has accomplished much in regions with a strong health and market infrastructure. However, in many developing countries, this necessary infrastructure is inadequate, non-existent, or simply does not serve rural areas where the vast majority of poor malnourished people live.

New approaches are needed to complement these existing strategies.

## Biofortification: A New Approach

Biofortification is a novel approach to breed higher levels of micronutrients directly into the staple food crops that the poor eat; this strategy takes advantage of their consistent daily consumption of large amounts of staples. These biofortified, or micronutrient-rich, staple foods can provide enough micronutrients to measurably improve nutrition when eaten daily. HarvestPlus uses the latest conventional and modern plant breeding techniques to improve the nutrient content of crops.

Biofortification has three key advantages. It is:

**Sustainable:** By improving the nutritional content of the staple foods that poor people already eat, biofortification can be a sustainable method to alleviate malnutrition using familiar foods.

**Targeted:** Biofortification can be an especially effective means of reducing malnutrition in rural areas, where about 75 % of the poor live, and where access to

supplements, commercially marketed fortified foods, or other urban-based interventions is limited.

**Cost-Effective:** Unlike traditional supplementation and fortification programs that continuously incur new costs, a biofortified crop can generate new biofortified varieties for farmers to grow for years to come in many different countries after a one-time initial investment. It is this multiplier aspect of biofortification across time and distance that makes it so cost-effective. There will be some recurrent expenditures for monitoring and maintaining high-micronutrient traits in crops, but these costs will be relatively low compared to other interventions.

## HarvestPlus: Breeding Crops for Better Nutrition

HarvestPlus is a Challenge Program of the Consultative Group on International Agricultural Research (CGIAR), a global alliance that mobilizes science to help the poor. HarvestPlus believes that by increasing the micronutrient content of staple foods consumed at each meal, biofortified crops can be an effective tool in reducing micronutrient malnutrition among poor people.

HarvestPlus focuses on three critical micronutrients recognized by the World Health Organization as most limiting in the diets of the poor: vitamin A, zinc, and iron. HarvestPlus envisions that in 15 years, up to 500 million people suffering from micronutrient malnutrition will be eating micronutrient-rich food crops. To date, HarvestPlus researchers have found that there is enough genetic variation in existing but underutilized germplasm to improve micronutrients levels in crops through plant breeding. Plant breeders are increasing micronutrient content of food crops to levels that will have a measurable and significant impact on human nutritional status. Nutritionists rigorously test new biofortified crops, and foods prepared from them,



Photo: IRRI



Photo: CIP

# Improve Human Nutrition

to ensure that they contain enough micronutrients to improve nutrition when eaten as part of the daily diet.

## From Field to Plate

Where scientists combine high micronutrient content with high yield and other agronomic attributes desired by farmers, it is likely that biofortified varieties will be successful. Participatory plant breeding that considers farmer's perspectives is effective in delivering a product that farmers want to grow. While farmers may be willing to grow biofortified crop varieties, poor households will also need to either grow or buy these crops and foods prepared from them. In most cases, micronutrient-rich food crops will have the same taste, texture, cooking qualities, and appearance as ordinary varieties. This makes it easier to introduce biofortified foods into the diet. When the additional nutrients result in a change in color or taste, behavioral change specialists work with communities to educate them on the nutritional benefits of micronutrient-rich crops.

## Marketing HarvestPlus Crops

HarvestPlus crops will only have impact if produced and consumed on a large scale, but in many developing countries delivery systems to get new crops to the poorest people are lacking. The CGIAR and private sector seed companies have gained valuable experience in developing local seed distribution systems, which offer a natural route for disseminating nutrient-rich seeds to poor farmers. HarvestPlus crops will not only be high yielding and have other agronomic traits desired by farmers, but will also provide nutritional benefits to their families and to those who buy and eat any surplus sold in the marketplace. To create demand for micronutrient-rich staple crops, HarvestPlus will apply lessons learned from public and private distribution strategies to position HarvestPlus crops as unique and desirable. HarvestPlus will work with households, communities, farmer organizations, extension

organizations, private seed producers, traders and retailers, local and international NGOs, and governments at all levels to make the adoption of biofortified crops a success.

## A New Food-Based Strategy

No single approach will solve the micronutrient malnutrition problem. A comprehensive strategy involving multiple interventions, such as supplementation and fortification, is needed. The permanent solution to micronutrient malnutrition is, of course, to diversify diets and encourage greater consumption of more nutritious foods. However, increasing food prices, poverty, and even lack of geographic access to diverse foods means that this may take decades to realize.

HarvestPlus crops can provide part of the recommended daily allowance of vitamins and minerals to help reduce, or prevent, micronutrient deficiencies. As a food-based strategy, biofortification effectively addresses the root causes of micronutrient malnutrition directly through the diet. It targets the poorest people, takes advantages of existing delivery mechanisms, and is extremely cost-effective. Breeding and disseminating micronutrient-rich crops is an essential first step in empowering rural households to improve family nutrition in a sustainable way.

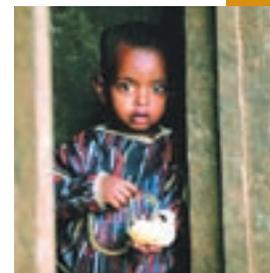


Photo: CIMMYT

*HarvestPlus is a global alliance of research institutions and implementing agencies that are working together to breed and disseminate crops for better nutrition. It is coordinated by the International Center for Tropical Agriculture (CIAT) and the International Food Policy Research Institute (IFPRI). HarvestPlus is an initiative of the Consultative Group on International Agricultural Research (CGIAR).*

Photo: CIMMYT



HarvestPlus brings together a range of knowledge and ability, including expertise in plant breeding, plant genomics, human nutrition, social behavior, economics and policy analysis, and communications. The program's efforts currently focus on seven staple food crops that will have the greatest impact in alleviating micronutrient malnutrition. These are rice, wheat, maize, bean, cassava, sweet potato, and pearl millet.

## Accomplishments and Plans

### Phase I (2003-2008): Discovery

- Screened nutrient levels in germplasm in focus crops.
- Set nutritionally optimal target levels for breeding.
- Conducted research to identify genes responsible for synthesis, degradation, and translocation of micronutrients.
- Initiated breeding programs to increase micronutrient density in crops to target levels.
- Assessed bioavailability of nutrients bred into the food staples and whether absorbed at sufficient levels to improve micronutrient status under controlled conditions.
- Identified promising promoting compounds to increase bioavailability of iron and zinc.
- Developed fast and low cost methods for nutrient measurement in crops and foods.
- Initiated consumer acceptance research to determine if farmers would adopt micronutrient-rich varieties and if consumers would buy and/or eat them in sufficient quantities to improve nutrition.
- Developed and applied methods for *ex ante* measurement of the impact of micronutrient-rich varieties.
- Implemented pilot dissemination programs with biofortified sweet potato in Uganda and Mozambique.
- Helped establish nationally supported biofortification programs in Brazil, China, and India.
- Published research findings in more than 100 peer-reviewed journals, books, and other academic and general interest publications.

### Phase II (2009-2013): Development

- Establish nutritional efficacy in target populations in focus countries.
- Develop specific nutrient and crop combination products targeted to selected regions in Africa and Asia.
- Increase collaboration with national agricultural research and extension service partners.
- Initiate in-country testing, breeding, adaption, and validation of micronutrient-rich crops.
- Facilitate formal varietal release of micronutrient-rich seed and planting material by national partners in target countries.
- Develop plans for dissemination of micronutrient-rich crop products to producers and consumers.
- Set up country teams for local promotion and dissemination.

### HarvestPlus III: Dissemination (2014-2018)

- Implement plans for dissemination of micronutrient-rich crop products to producers and consumers.
- Assist national institutions in disseminating micronutrient-rich crop varieties.
- Promote and support biofortification as an integral component of core breeding programs at international and national agricultural research centers.
- Conduct *ex-post* impact and effectiveness analysis to determine effectiveness of biofortified crops in reducing micronutrient malnutrition.

### Collaborating CGIAR Research Centers

Africa Rice Center (WARDA) • Bioversity International • International Center for Tropical Agriculture (CIAT)\* • International Center for Maize and Wheat Improvement (CIMMYT) • International Potato Center (CIP) • International Center for Agricultural Research in the Dry Areas (ICARDA) • International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) • International Food Policy Research Institute (IFPRI)\* • International Institute of Tropical Agriculture (IITA) • International Rice Research Institute (IRRI)

\* Convening research center

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