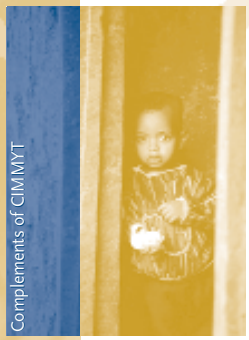
Biofortified Maize


Complements of CIMMYT

Maize is the preferred staple food of more than 1.2 billion people in Sub-Saharan Africa and Latin America. Over 50 million people in these regions are vitamin A deficient. Maize-based diets, particularly those of extremely poor individuals, often lack essential vitamins such as vitamin A. Dietary sources occur either as preformed vitamin A, as in dairy and other foods from animal sources, or as provitamins A, as found in plant foods, including maize. Identifying and increasing the supply of maize cultivars rich in provitamins A may greatly improve the health and longevity of people around the world.

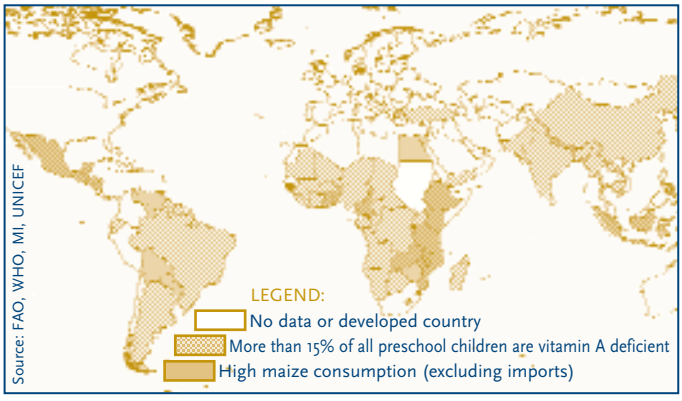
Researchers are currently screening germplasm samples of existing maize varieties to identify micronutrient-dense varieties for development through conventional breeding. International research institutes, primarily the International Maize and Wheat Improvement Center (CIMMYT) and the International Institute for Tropical Agriculture (IITA), are conducting most of the preliminary breeding work. Adaptive breeding for local conditions will be carried out in partnership with national agricultural research and extension systems (NARES) in Latin America and Africa to ensure that the new varieties are competitive in terms of grain yield and other important traits compared with currently grown varieties.

Strategy

HarvestPlus maize research originally concentrated on increasing provitamins A carotenoids in maize. Efforts to increase the concentration of iron in maize through conventional breeding programs were hampered by limited natural variation. In 2005, however, potential new sources for high iron and zinc were identified. Initial target countries for dissemination of biofortified maize are Brazil, Ethiopia, Ghana, Guatemala, and Zambia. Research in the United States and at CIMMYT has focused on finding genetic markers to facilitate selection in breeding programs aimed at enhancing provitamins A levels.

In 2006, national program teams will continue to screen local germplasm and conduct adaptive breeding research, including farmer-participatory variety evaluations. Once biofortified maize varieties are available, teams will be formed in each of the primary target countries to facilitate extension and dissemination of the new varieties so as to encourage widespread acceptance and create demand for biofortified varieties. A key feature of this strategy will be the formation of alliances in each target country or in sub regions within countries to accomplish the following tasks:

- With extension services and nongovernmental organizations: organize and coordinate farmer-participatory evaluation of biofortified varieties.
- With university, industry, or government nutritionists and food technologists: assess the effect of local food processing on bioavailability of provitamins A and other minerals.
- With nutritionists, other HarvestPlus project teams, and ministries of health and education: formulate and implement a nutrition advocacy program, including promoting adoption of biofortified maize varieties.
- With seed producers and retailers, and with food and feed industries: develop a strategy to ensure access to the selected biofortified varieties by the farmers and consumers who will benefit most from their use.



Lessons Learned

Screening is currently underway to assess the micronutrient concentrations in yellow and white maize germplasm. HarvestPlus scientists have discovered germplasm with maximum iron and zinc concentrations of 40–45 mg/kg and 50–62 mg/kg respectively. Based on nutritionists' estimates, iron and zinc levels of 60 and 55 mg/kg, respectively, are required for biofortified maize to have an impact on nutrition. For provitamins A, screening revealed maximum levels between 5.0 and 8.6 µg/g,

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although a few temperate inbred maize lines showed levels of nearly 15 µg/g. Even though results need to be confirmed, the presence of genetic variation in genetically unrelated sources seems to be present. These results suggest that the approximate target for provitamins A of 15 µg/g can be accomplished via conventional breeding.

Extensive nutrition research is being conducted in collaboration with members of the HarvestPlus nutrition alliance. Two central components of these research activities are developing methods to accurately screen and measure micronutrient content for breeding purposes, and testing the retention and bioavailability of provitamins A and other nutrients in biofortified products.

HarvestPlus Maize Alliance

Country/Region	Institute
Australia	Adelaide University School of Agriculture, Waite Campus
Brazil	Brazilian Agricultural Research Corporation (Embrapa)
Ethiopia	Ethiopian Agricultural Research Organization (EARO)
	Ethiopian Health and Nutrition Research Institute (EHNRI)
Ghana	Ghana Crops Research Institute (CRI)
Germany	University of Freiburg
Guatemala	Instituto de Ciencia y Tecnología Agrícola (ICTA) de Guatemala
Mexico	Instituto Nacional de Investigaciones Forestales, Agrícolas y Pecuarias de México (INIFAP)
Nigeria	International Institute of Tropical Agriculture (IITA)
United States	International Food Policy Research Institute (IFPRI)
	Cornell University U.S. Plant, Soil & Nutrition Laboratory,
	United States Department of Agriculture-Agricultural Research Service (USDA-ARS)
	Iowa State University
	University of Illinois
	Michigan State University
Zambia	Zambian Ministry of Agriculture
Regional	Africa Agriculture Technology Foundation
International	Sasakawa Global 2000

Selected Publications

Nesamvuni, A. E., **H. H. Vorster**, **B. M. Margetts**, and **A. Kruger**. 2005. Fortification of maize meal improved the nutritional status of 1- to 3-year-old African children. *Public Health Nutrition* 8 (5): 461–467.

Long, J. K., **M. Bänziger**, and **M. E. Smith**. 2004. Diallele analysis of grain iron and zinc density in southern African-adapted maize inbreds. *Crop Science* 44: 2019–2026.

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Oikeh, S. O., **A. Menkir**, **B. Maziya-Dixon**, **R. Welch**, and **R. P. Glahn**. 2003. Assessment of concentrations of iron and zinc and bioavailable iron in grains of early-maturing tropical maize varieties. *Journal of Agricultural*. *Food Chemistry* 51: 3688–3694.

Banziger, M., and **J. Long**. 2000. The potential for increasing the iron and zinc density of maize through plant breeding. *Food and Nutrition Bulletin* 21 (4): 397–400.

Graham, R., **D. Senadhira**, **S. Beebe**, **C. Iglesias**, and **I. Monasterio**. 1999. Breeding for micronutrient density in edible portions of staple food crops: Conventional approaches. Field Crops Research. 60: 57–80.

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